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295 477

Flight Data Report No. 5

Contract AF 33(616)-7633

BALLOON FLIGHTS OF APRIL 9 AND MAY 23, 1962

David G. Murcray
James N. Brooks
Jay O. Green
Marie M. Working

Research Reported in This Document Has Been Supported by
Aeronautical Systems Division
Air Force Systems Command
United States Air Force

27 December 1962

- Submitted by -

Denver Research Institute
University of Denver
Denver 10, Colorado

CATALOGED
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ABSTRACT

This report presents the results obtained on balloon flights made with an automatic programmed radiometer system. The equipment was launched from Holloman AFB, New Mexico, April 9 and May 23, 1962. The radiometer was equipped with a liquid oxygen cooled In Sb cell as a detector and measurements were made of the infrared background radiation from 1.8 μ to 5.0 μ .

I. INTRODUCTION

This is one of a continuing series of flight data reports issued on contract AF 33(616)-7633. These reports present infrared and ultraviolet background radiation data obtained by means of a balloon-borne automatic programmed radiometer system. The results contained in this report were obtained during balloon flights made from Holloman Air Force Base, New Mexico, April 9 and May 23, 1962.

II. INSTRUMENTATION

The instrumentation has been described in detail in previous flight data reports and the description will not be repeated here. The radiometer scanning motion used on these flights was the same as that used on the March 21 flight and is described in flight data report number 4. In order to keep the report self-contained, filter transmission curves for the filters used in the radiometer are given in figures 1 through 4. The detector used on the infrared channel was a liquid oxygen-cooled In Sb cell and that for the ultraviolet was a quartz window Dumont photomultiplier tube.

The method of calibration of the instrumentation is described in detail in flight data report number 4.

III. FLIGHT DETAILS

The April 9 flight was launched at 0544 M.S.T. The balloon ascended with an average ascent rate of 200 meters/min and reached a floating altitude of 31 kilometers. The winds at all altitudes were from the west and the balloon drifted to the east. The balloon was cut down at 1000 M.S.T. and impacted in the vicinity of Lovington, New Mexico.

Cloud cover in the Alamogordo area at the time of launch consisted of 5/10 high cirrus. This increased during the early morning to 7/10 to 8/10 high cirrus. All weather stations in the region scanned by the radiometer system during the flight reported 6/10 to 8/10 high cirrus.

No data are available on the height of the cirrus other than that the majority of the clouds were estimated to be higher than 10 kms. As the balloon ascended after launch it was observed to enter a cirrus cloud of sufficient thickness to obscure it from view at the time that the radar tracking gave its elevation as 12.5 kilometers.

The May 23 flight was launched at 0600 M.S.T. and ascended with an average ascent rate of 200 meters/min and also reached a floating altitude of 31 kilometers. The winds at the lower altitudes were from 240° and the balloon moved out on a heading of 60° until it reached an altitude of 28 km when it turned North. At this time it was 80 kms out from Holloman and most of the data were taken when the balloon was over the eastern slope of the Sacramento Mountains. The equipment was cut down at 1100 M.S.T. and impacted near Three Rivers, New Mexico.

All weather stations in the area scanned by the radiometer system during the flight reported less than 1/10 cloud cover.

IV. RESULTS

All equipment operated properly on the April 9 flight until 0750 M.S.T. At this time a transistor in the analog to digital converter failed, and no further data were obtained.

On the May 23 flight everything operated properly until 0805 M.S.T. when the motor which drives the front mirror of the radiometer system failed. At the time the motor stopped the mirror was in a position where the radiometer was scanning above the horizon, and no further useful data were obtained.

The results obtained on the April 9 flight are given in figures 5 through 22. As mentioned above, these data were obtained with the radiometer system scanning a region covered with 7/10 to 8/10 high cirrus clouds.

The data obtained on the May 23 flight are given in figures 23 through 40. The weather in the region scanned by the radiometer while these data were taken was characterized by clear skies.

As before, the data are presented in the form of cumulative probability distribution curves for the radiance, the gradient of the radiance and the number of occurrences of equivalent point sources of various intensities. The gradient was determined by dividing the absolute value of the difference of successive values of the radiance by the angular separation between the directions in which the radiances were observed. The occurrence of equivalent point sources was determined by comparing three successive values of the radiance. Thus, if the three radiance values are denoted by N_1 , N_2 , N_3 , the difference $N_2 - N_1$ is compared to $N_2 - N_3$ and a point source of intensity proportional to

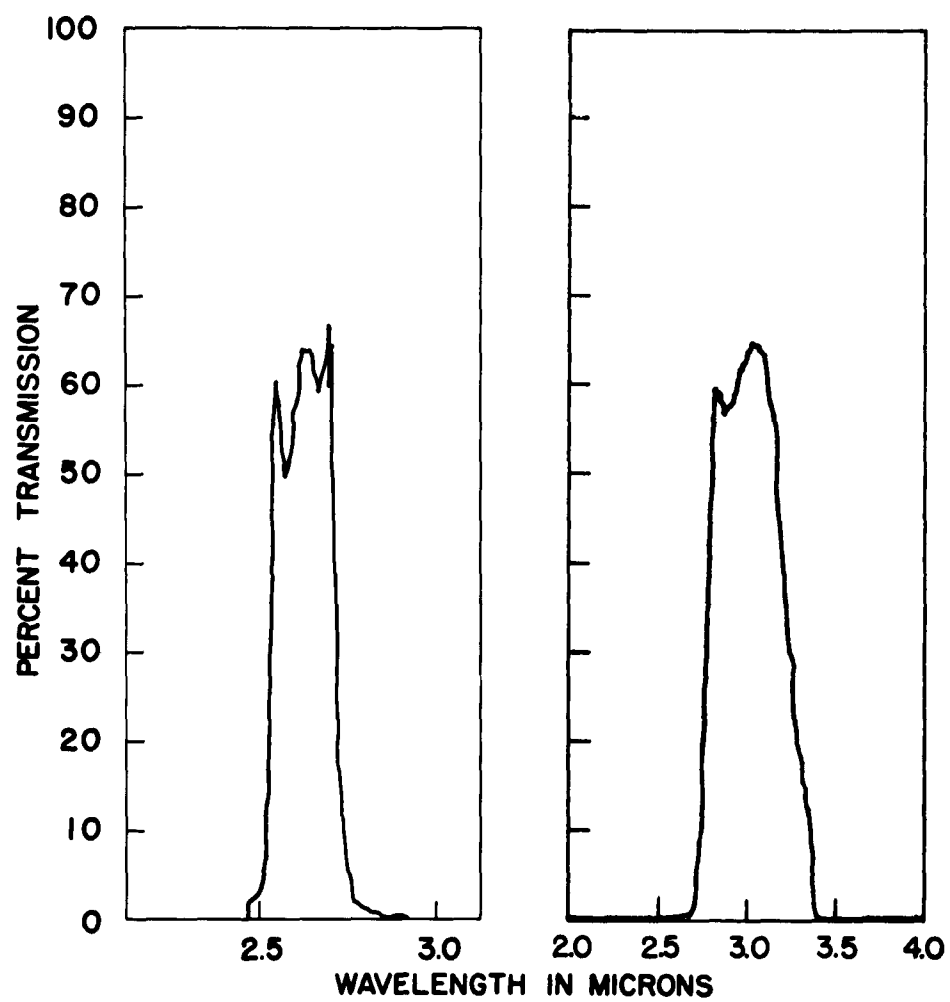
$N_2 - N_1$ is taken to have occurred if $N_2 - N_3$ is at least 80% of $N_2 - N_1$. The frequency of occurrence of point sources is so small that the number of occurrences is given rather than percentages. These numbers are placed on the gradient plots above the corresponding levels. In order to convert the gradient scales to watts/cm² at the aperture of the radiometer system for the point source data, the scales should be multiplied by 1.25×10^{-7} steradian degree for the infrared channel and by 2.2×10^{-6} steradian degree for the ultraviolet channel.

In addition to the above plots, the data taken during an azimuth scan were also sorted according to scattering angle. The median value of the radiances observed at a given scattering angle was determined and these median values are plotted against scattering angle. These plots are included with the other data for each filter. It should be pointed out that, because of the scattering angle geometry and the method of scanning, the number of observations at a given scattering angle may vary by an order of magnitude from the number at a different scattering angle. Because of the small number of points occurring at certain scattering angles, these plots show details that will not be observed on the radiance distribution curves.

V. ERRATA

Flight data report number 4 contained a number of errors which were not detected before the report was issued. Rather than issuing errata sheets which cannot be bound into the report and hence can easily be lost, these errata are listed below. It is hoped that recipients of this report will take time enough to make the appropriate corrections on the earlier reports. The following errors have been noted to data in flight data report number 4:

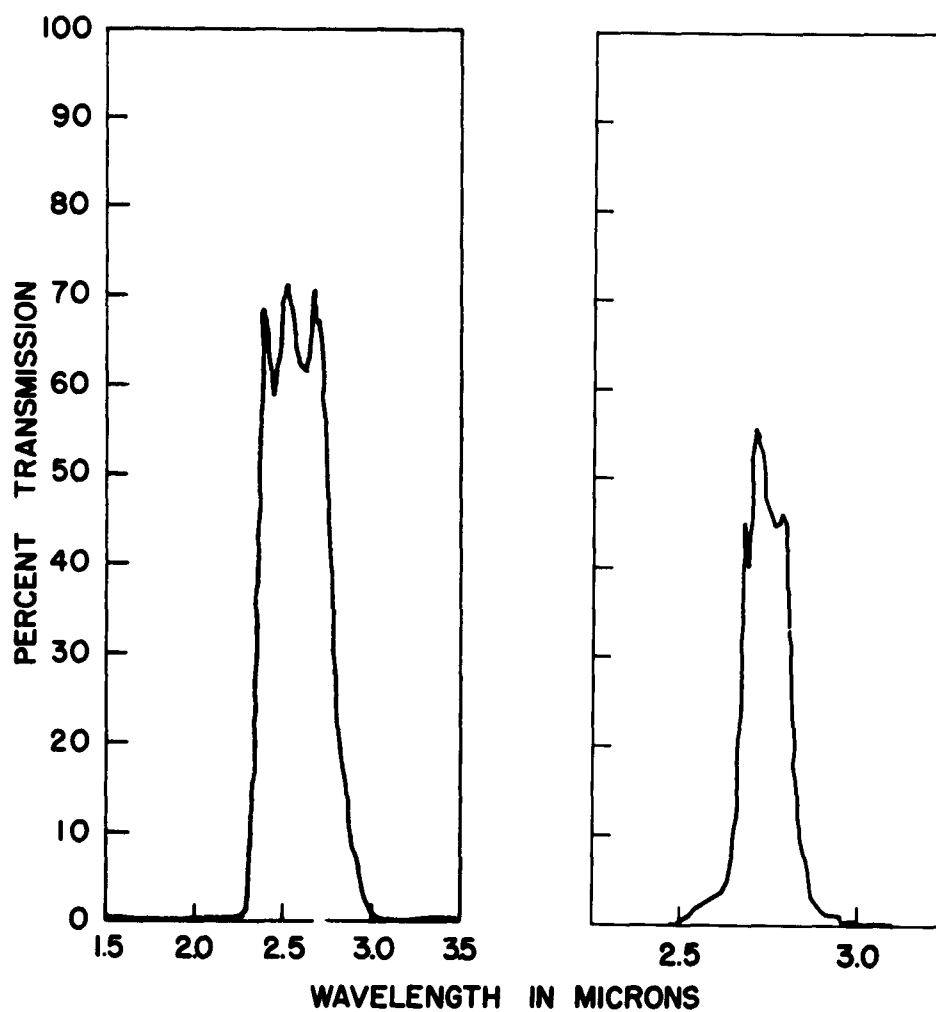
- Page 10 Figure 4 Caption should read UV Filter Nos. 6, 10
- Page 11 Figure 5 Caption should read UV Filter No. 4
- Page 28, 29 Figure 14 All abscissa scales are 1.3μ watts/cm² steradian too high, i.e. scale should read -1.3, -.3, .7, 1.7, etc.
- Page 32, 33 Figure 16 Same as above
- Page 36, 37 Figure 18 Same as above
- Page 64, 65 Figure 32 All abscissa scales are in error by factor 100. Radiation range should be .15, .30, .45, .60 m watts/cm² steradian.



IR Filter No. 1

IR Filter No. 2

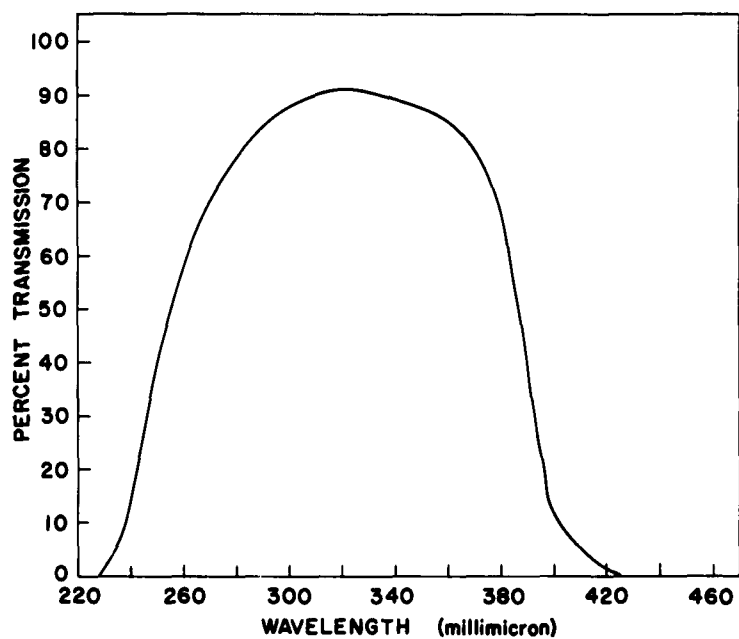
Figure 1



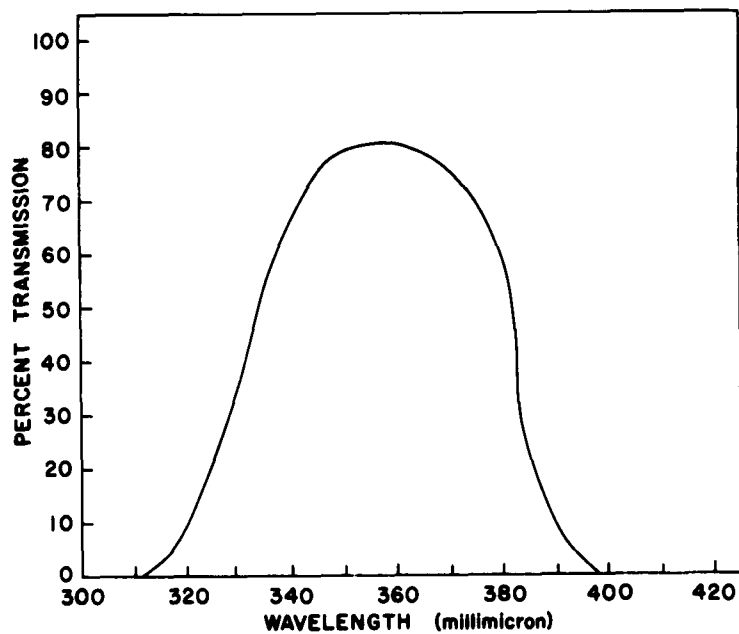
IR Filter No. 3

IR Filter No. 4

Figure 2

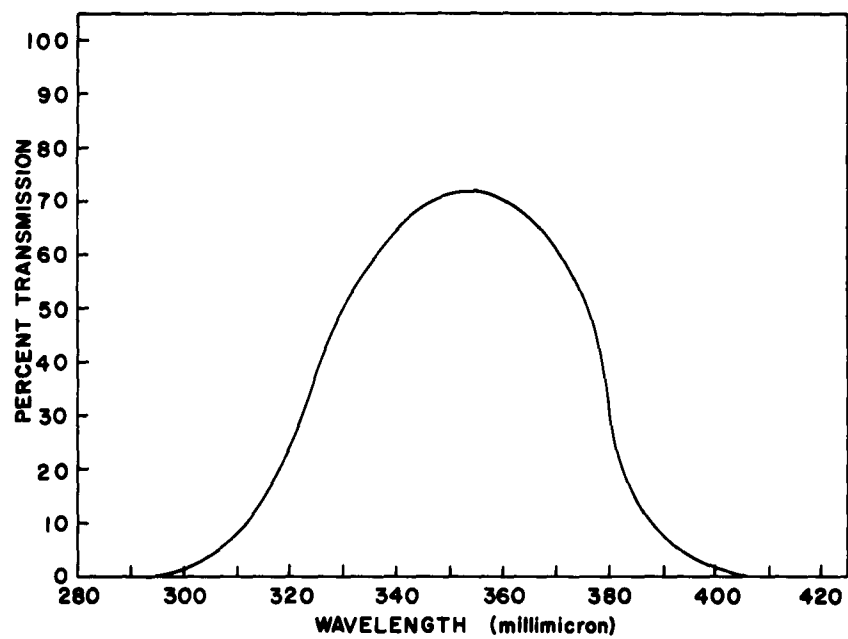


UV Filter Nos. 1, 9

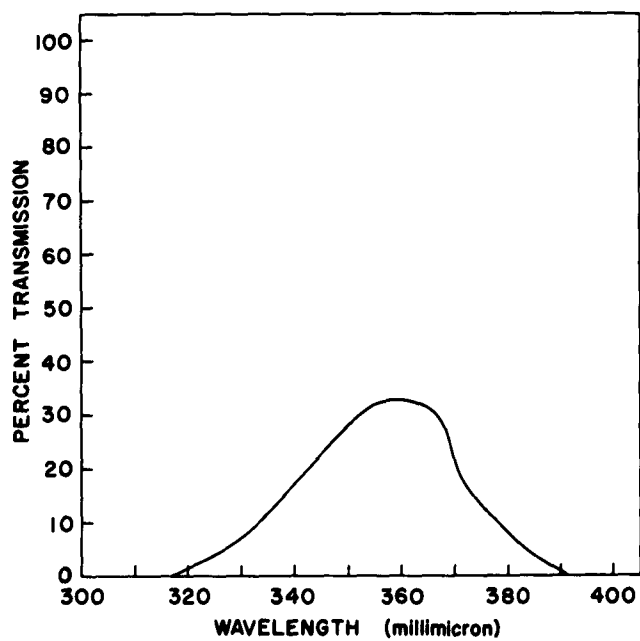


UV Filter Nos. 6, 10

Figure 3

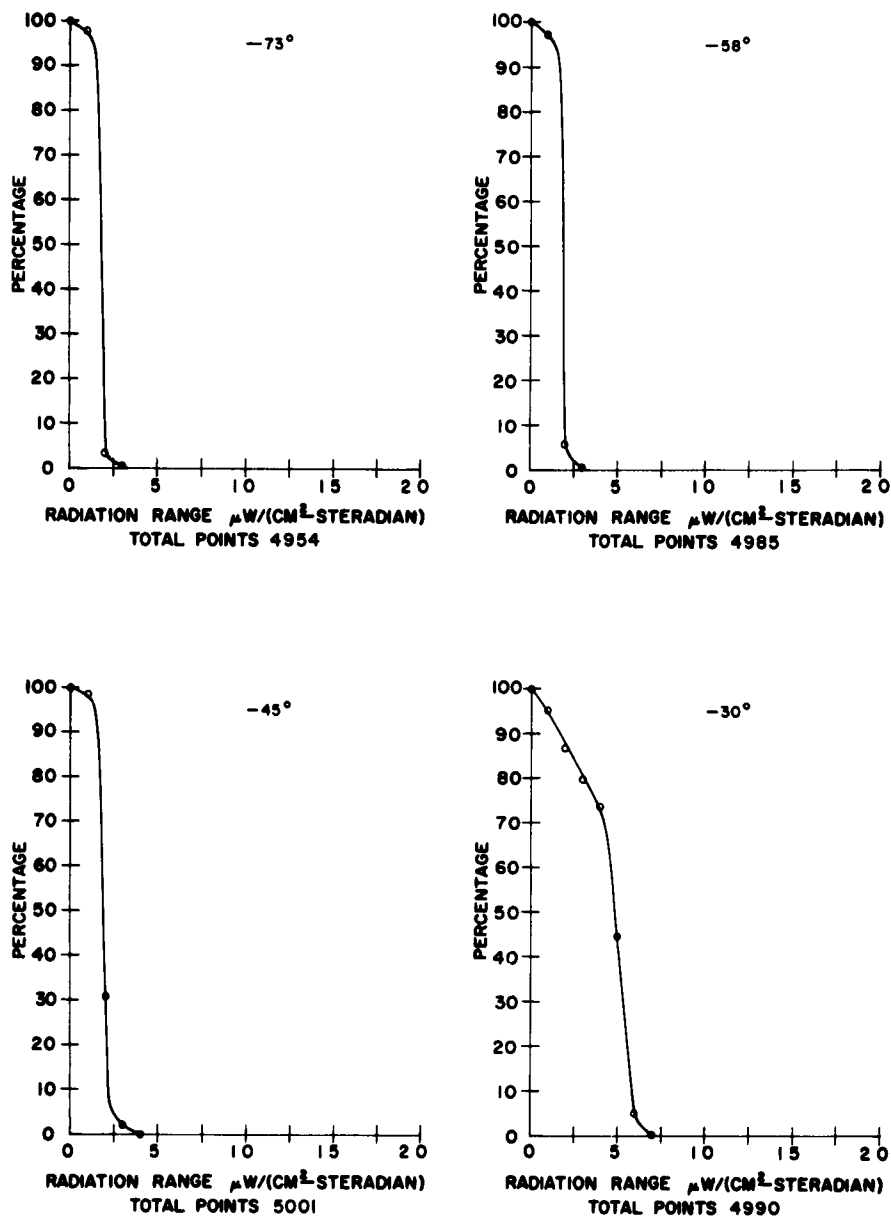


UV Filter No. 7



UV Filter No. 8

Figure 4



Distribution of IR Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 4 7:05-7:15 M.S.T.
 Altitude 23.8 km

Figure 5

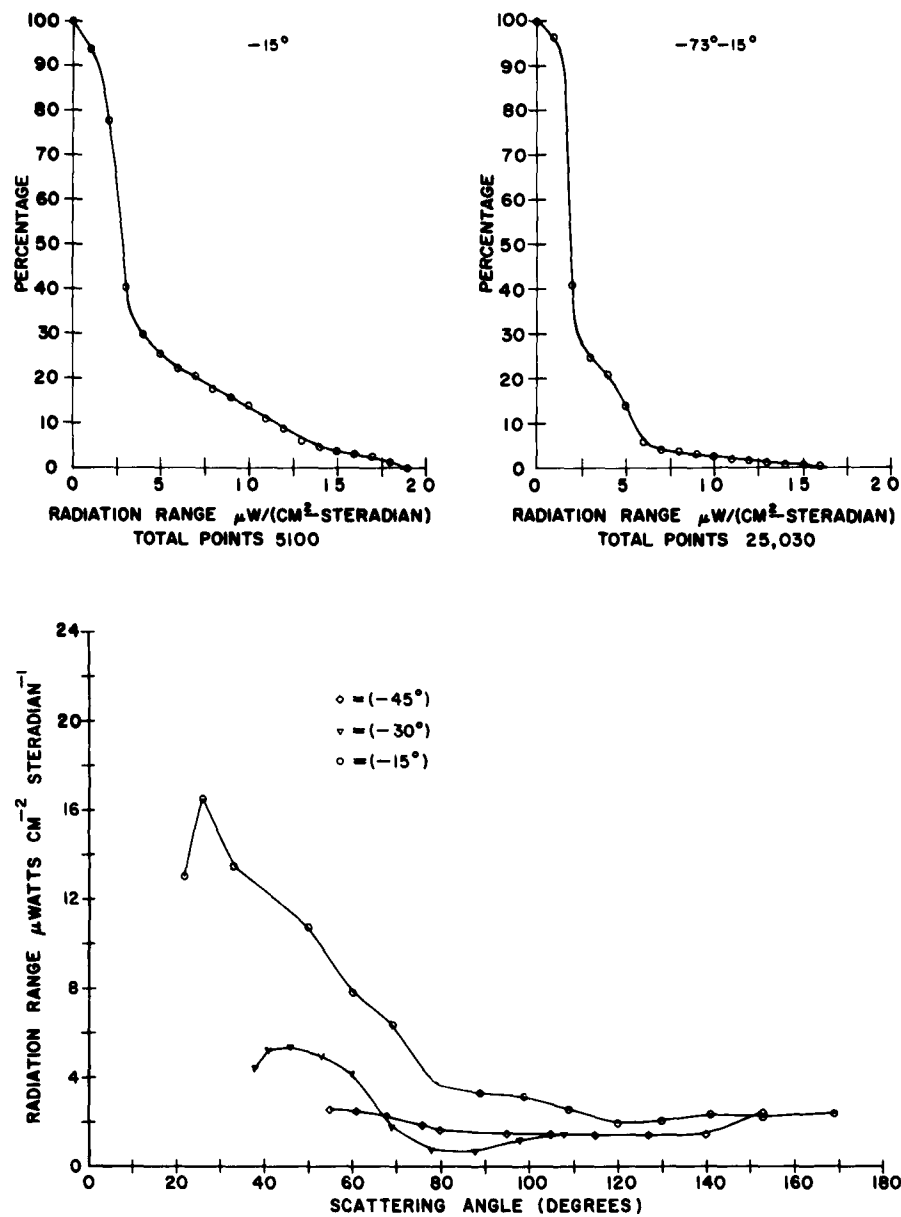
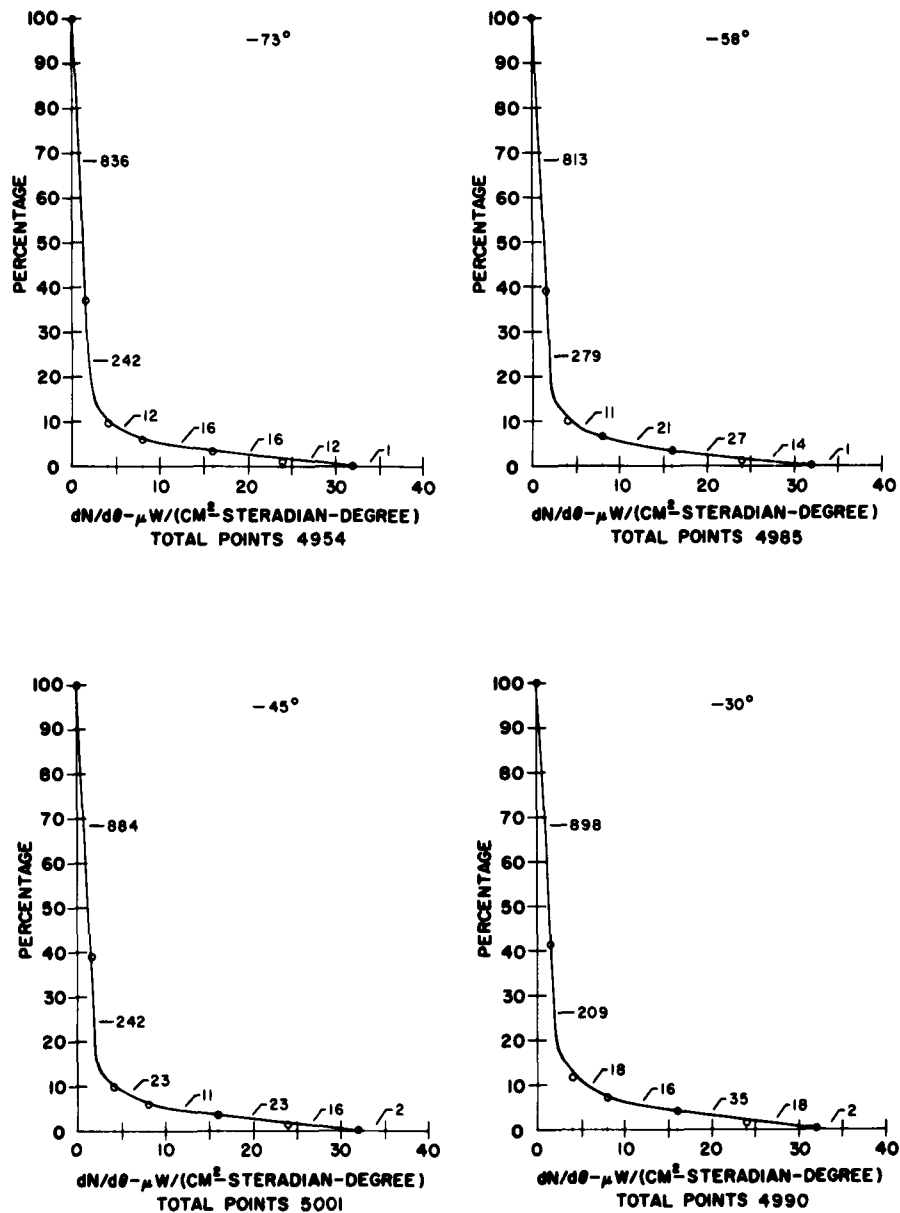


Figure 5 (cont.)



Distribution of IR $dN/d\theta$ with Elevation
 Filter No. 4 7:05-7:15 M.S.T.
 Altitude 23.8 km

Figure 6

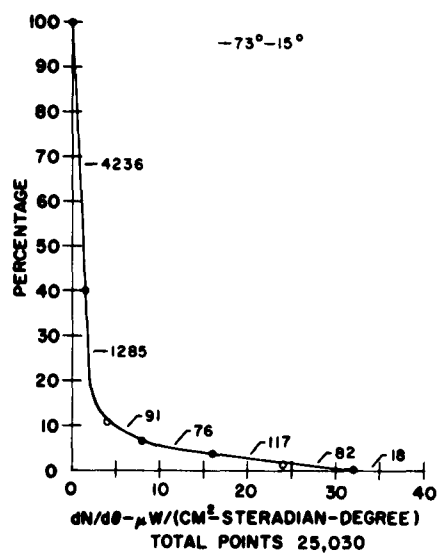
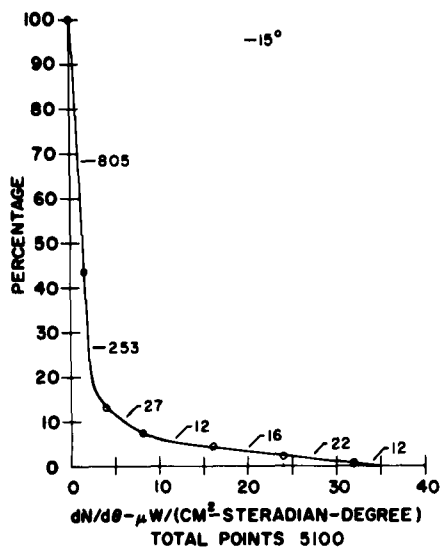
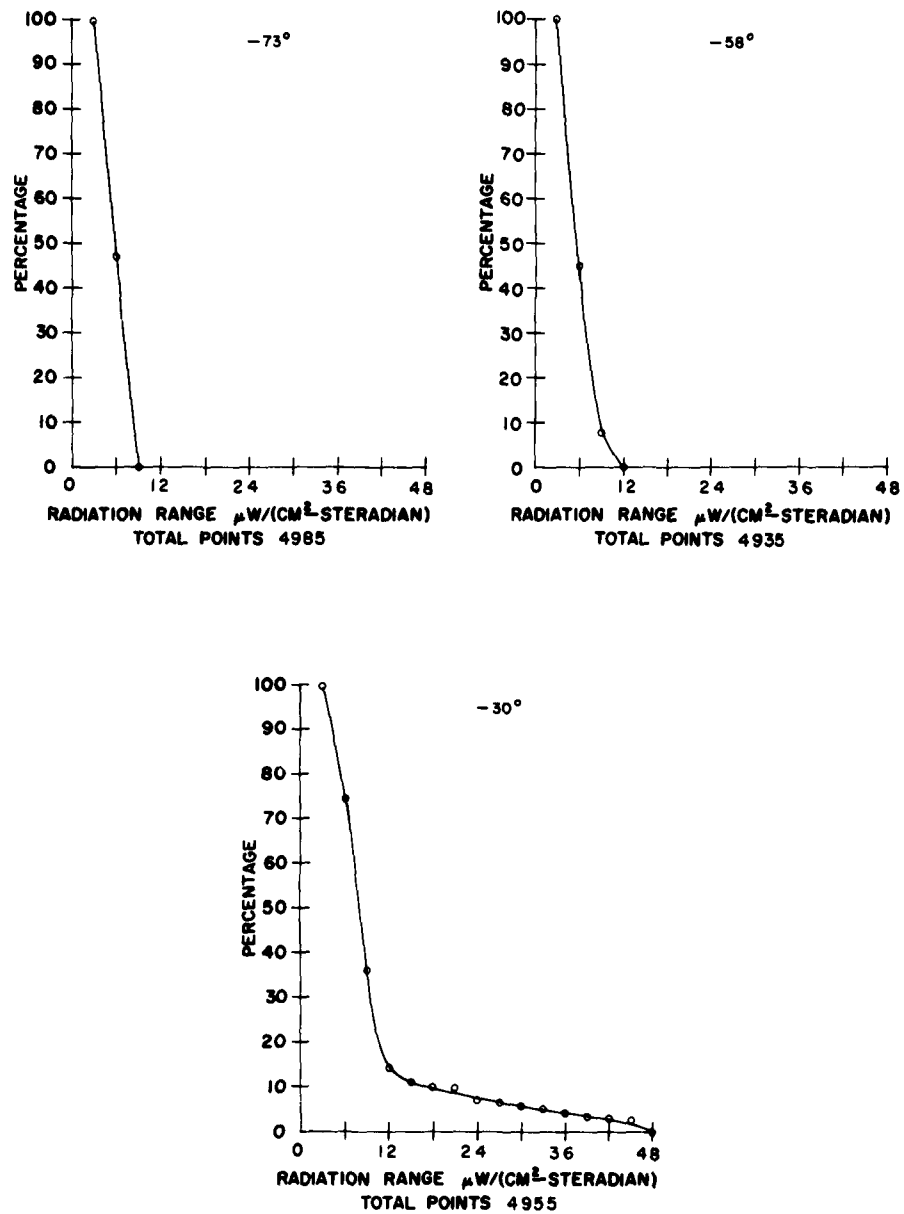


Figure 6 (cont.)



Distribution of IR Radiance with Elevation
 Filter No. 3 7:15-7:25 M. S. T.
 Altitude 26.2 km

Figure 7

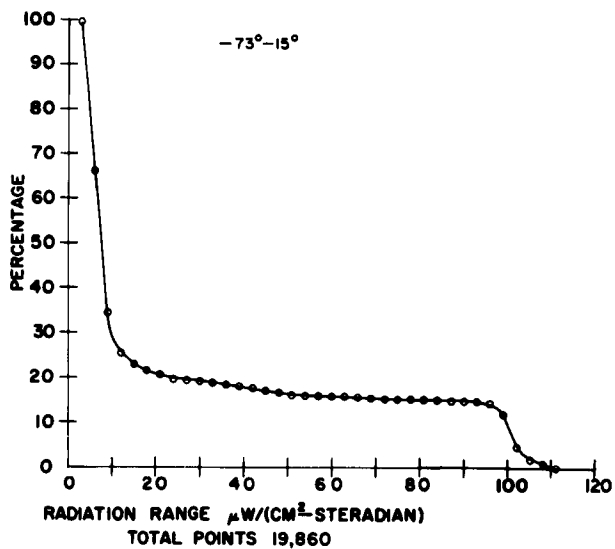
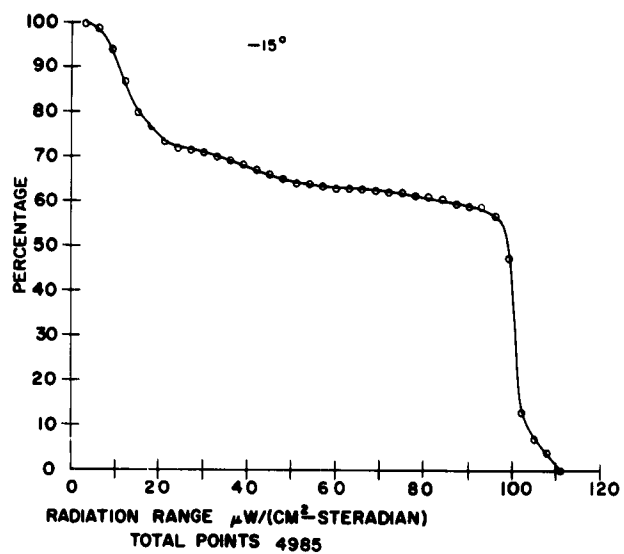
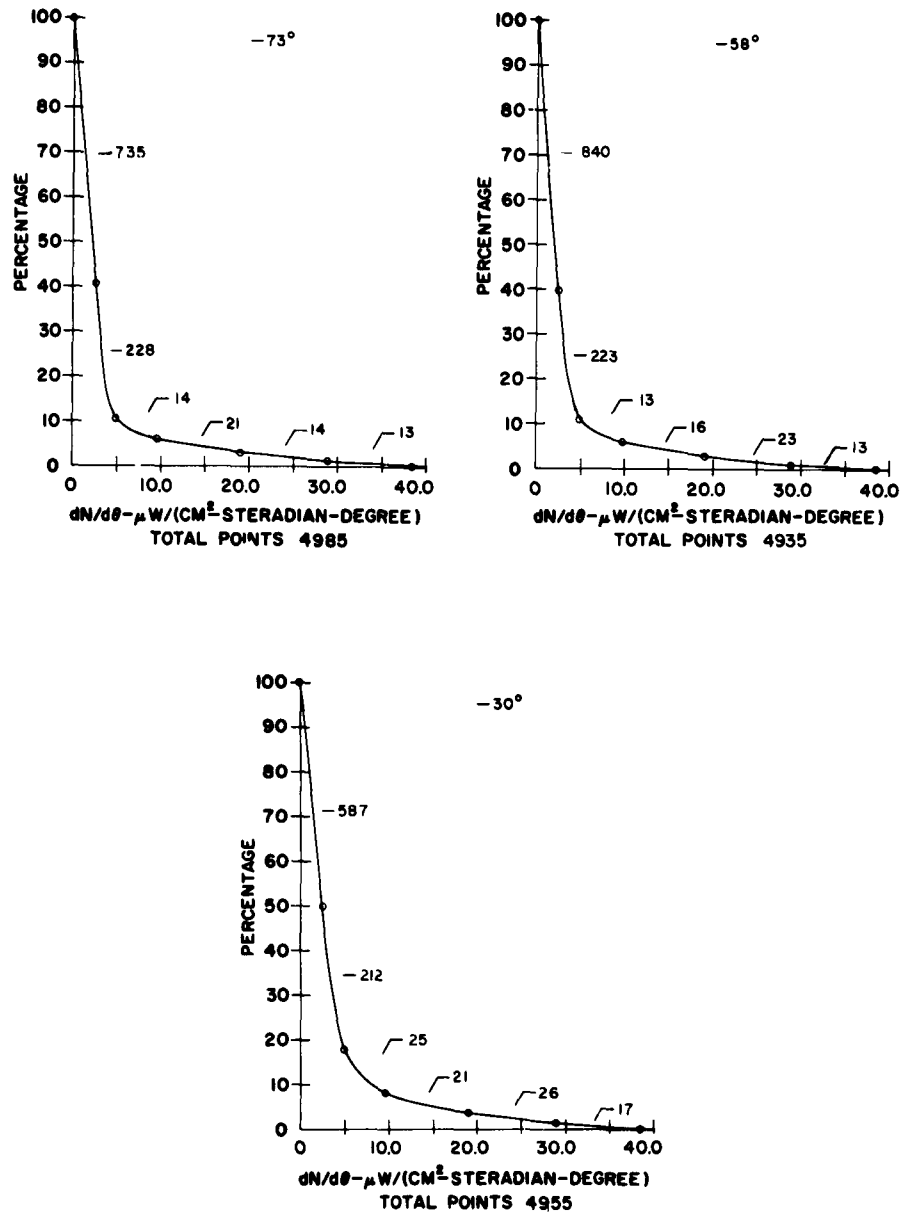


Figure 7 (cont.)



Distribution of IR $dN/d\theta$ with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 3 7:15-7:25 M.S.T.
 Altitude 26.2 km

Figure 8

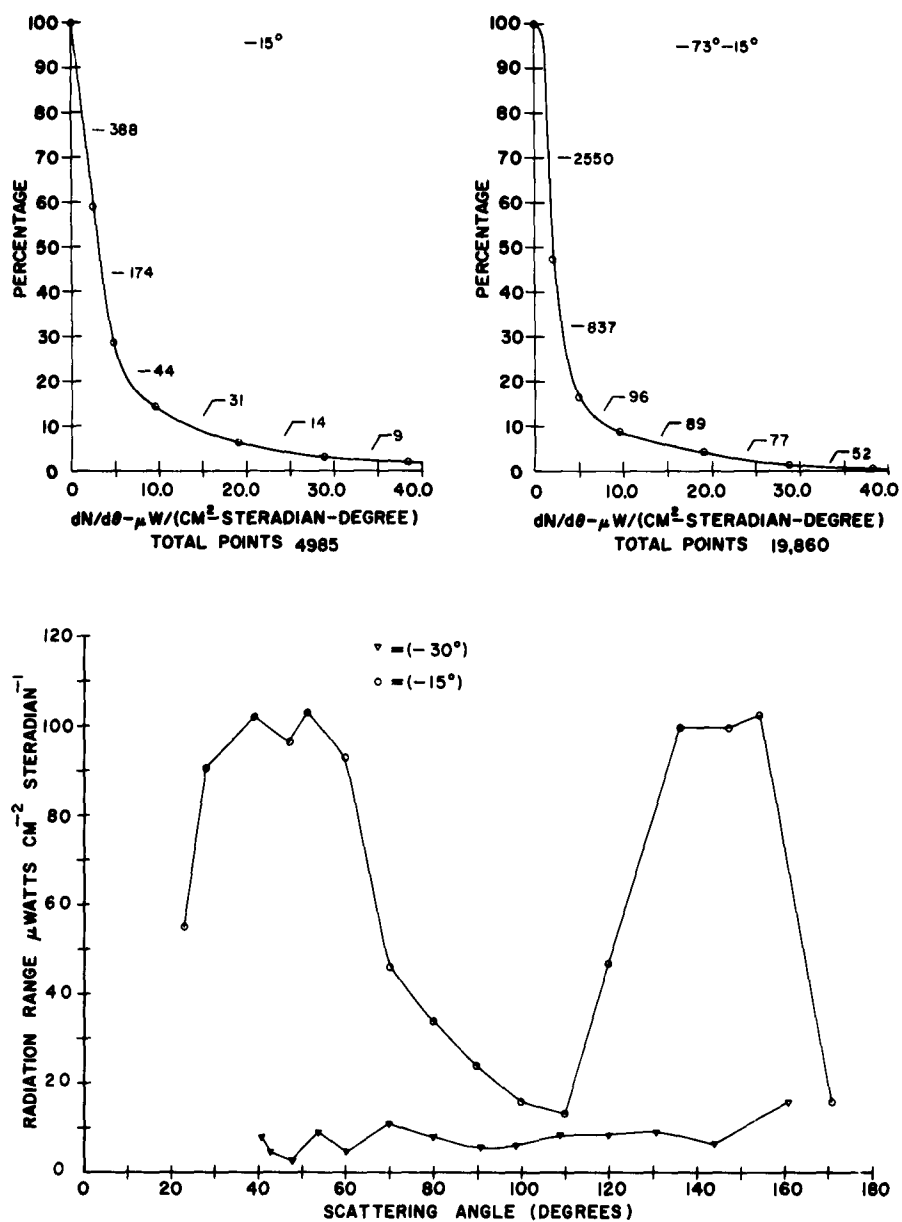
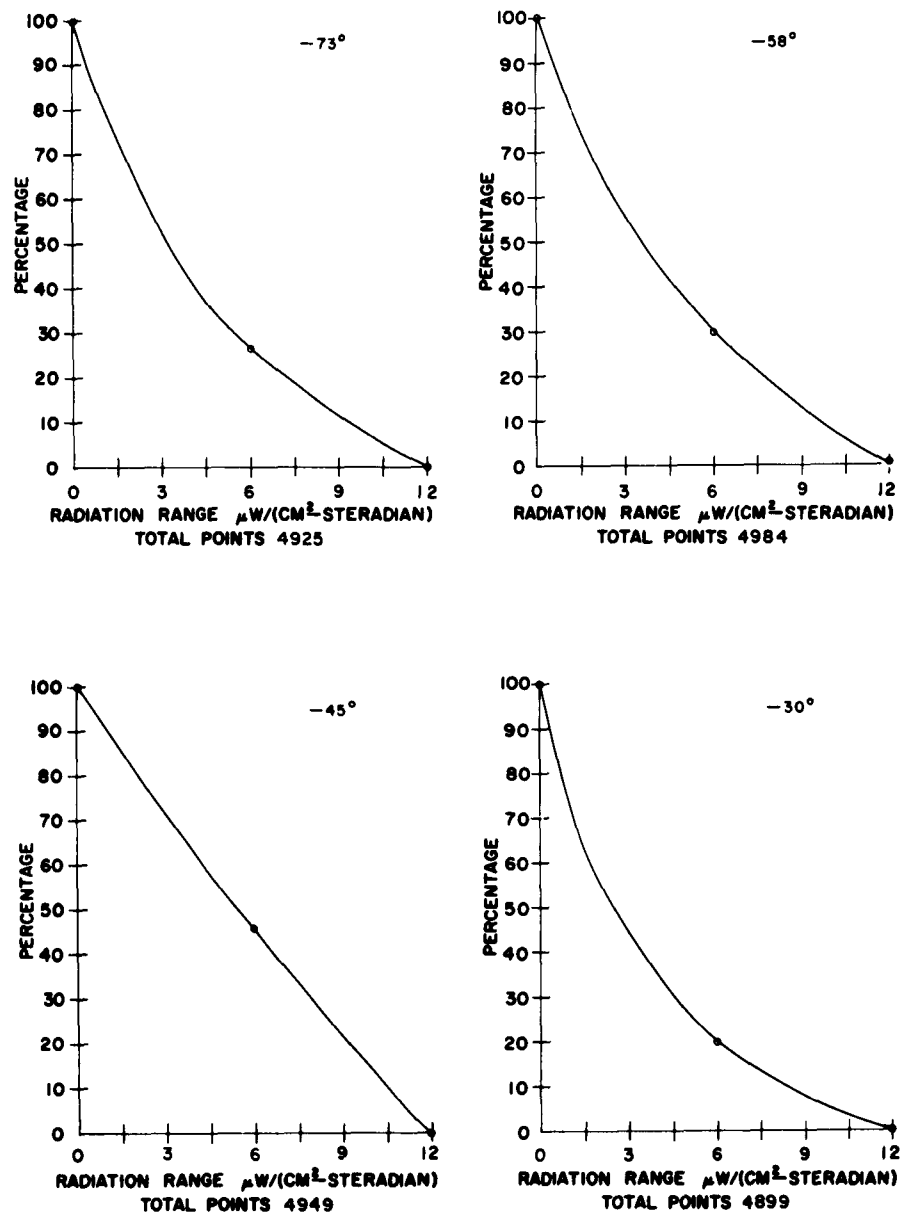


Figure 8 (cont.)



Distribution of IR Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 2 7:25-7:35 M.S.T.
 Altitude 28.7 km

Figure 9

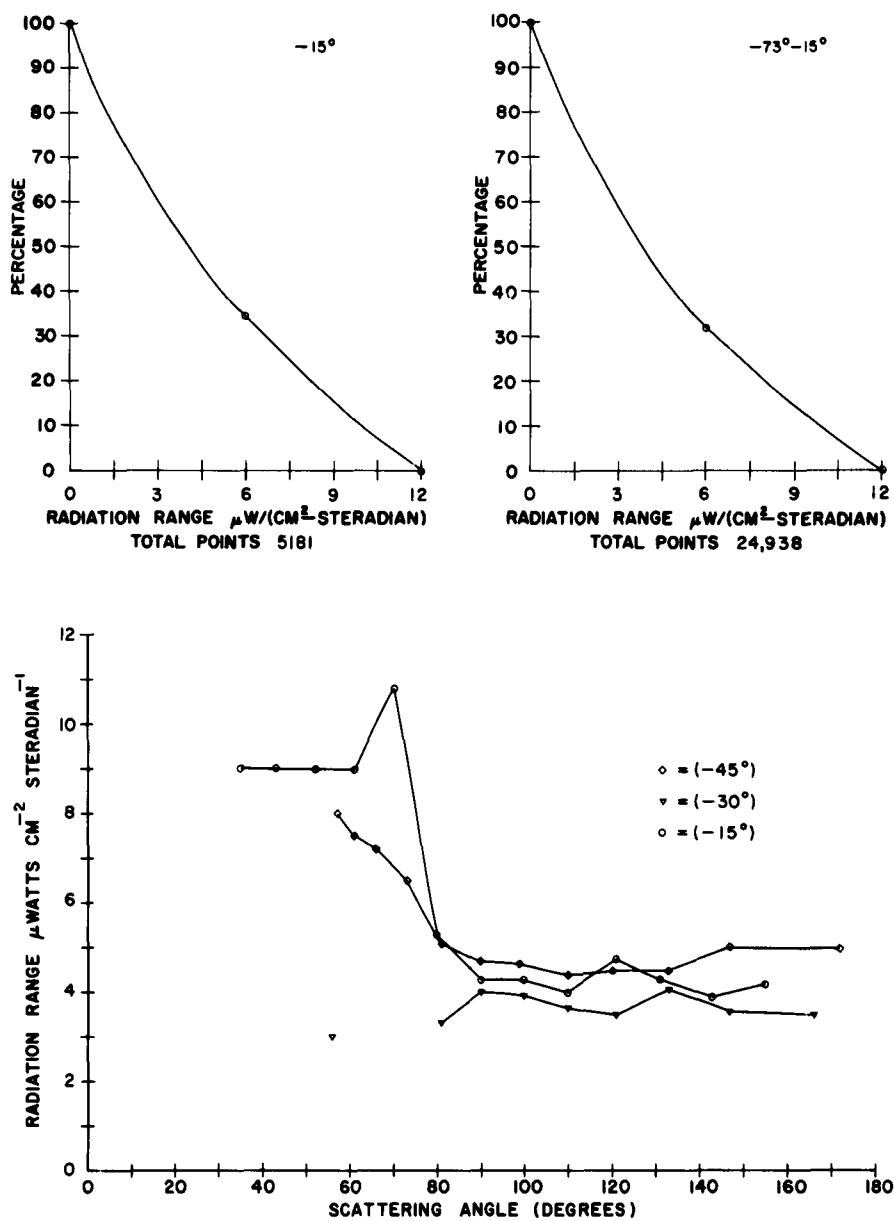
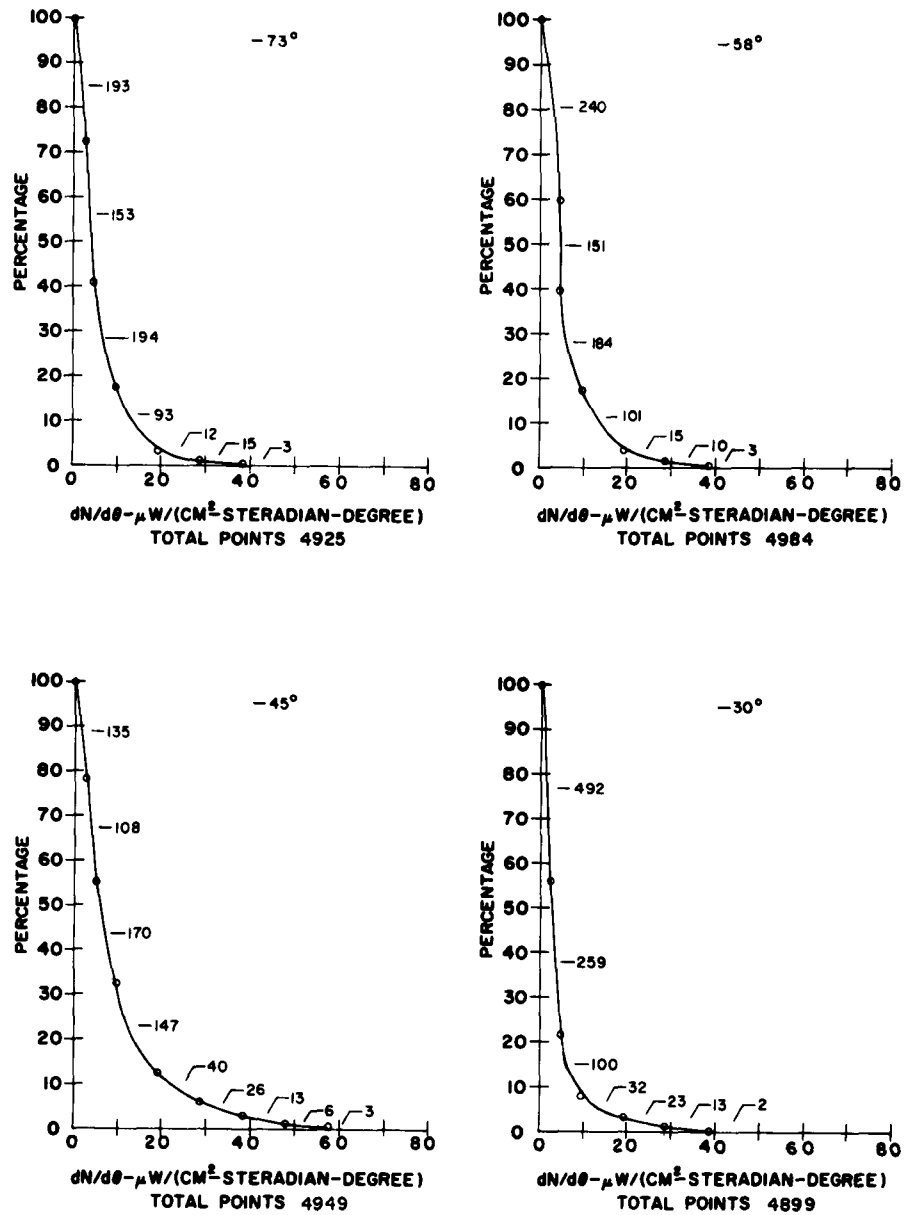


Figure 9 (cont.)



Distribution of IR $dN/d\theta$ with Elevation
 Filter No. 2 7:25-7:35 M.S.T.
 Altitude 28.7 km

Figure 10

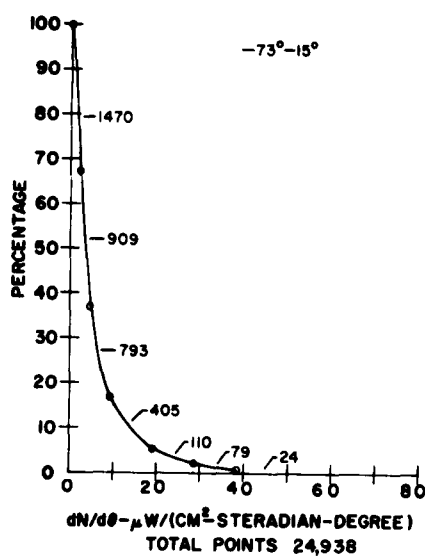
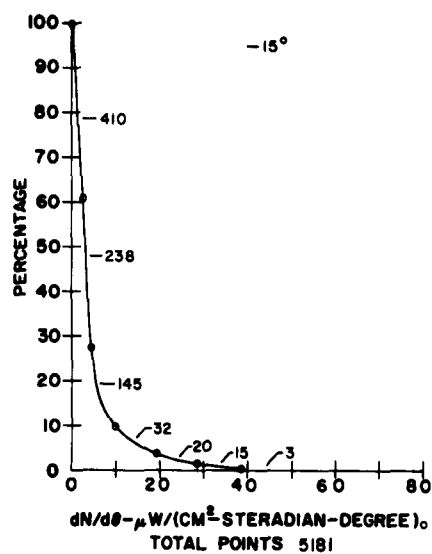
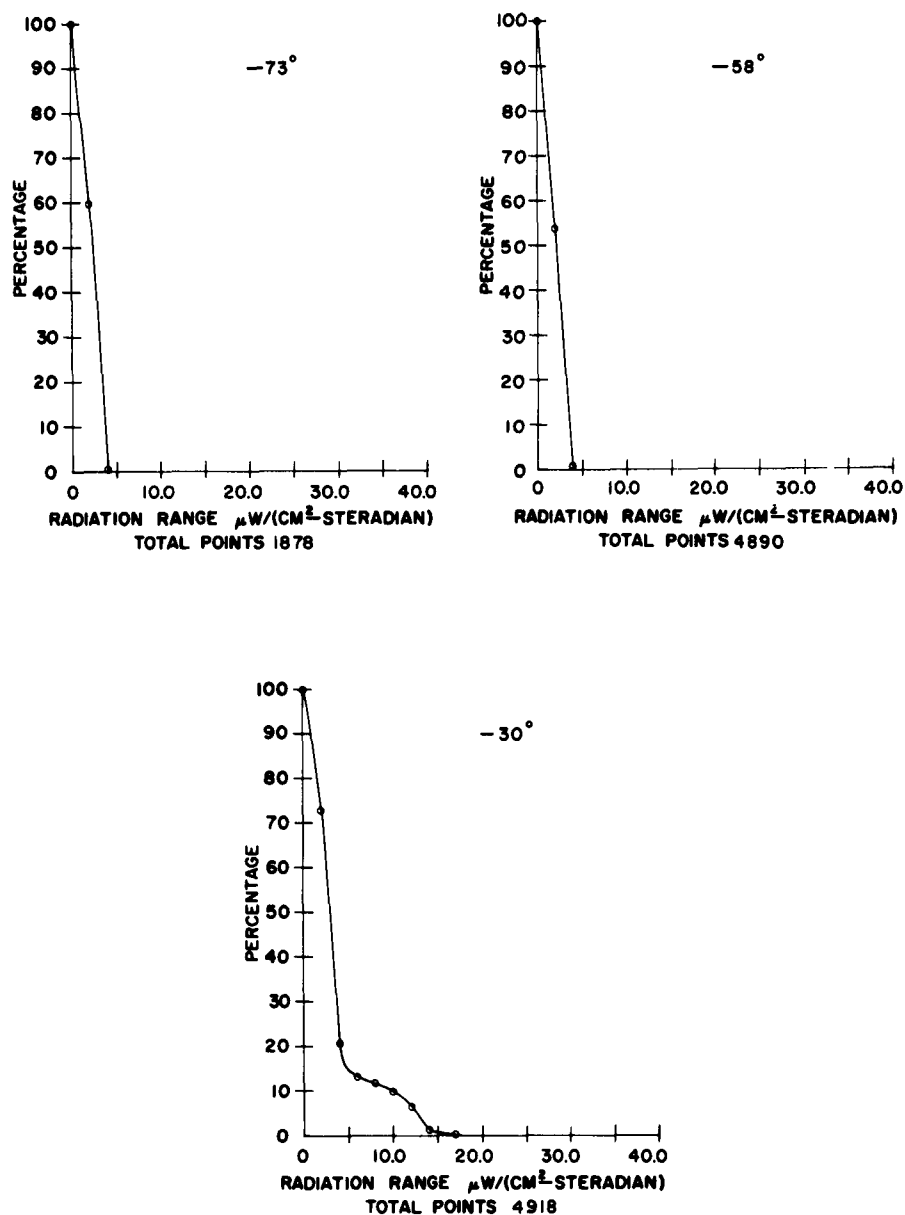


Figure 10 (cont.)



Distribution of IR Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 1 7:35-7:40 M. S. T.
 Altitude 31.1 km

Figure 11

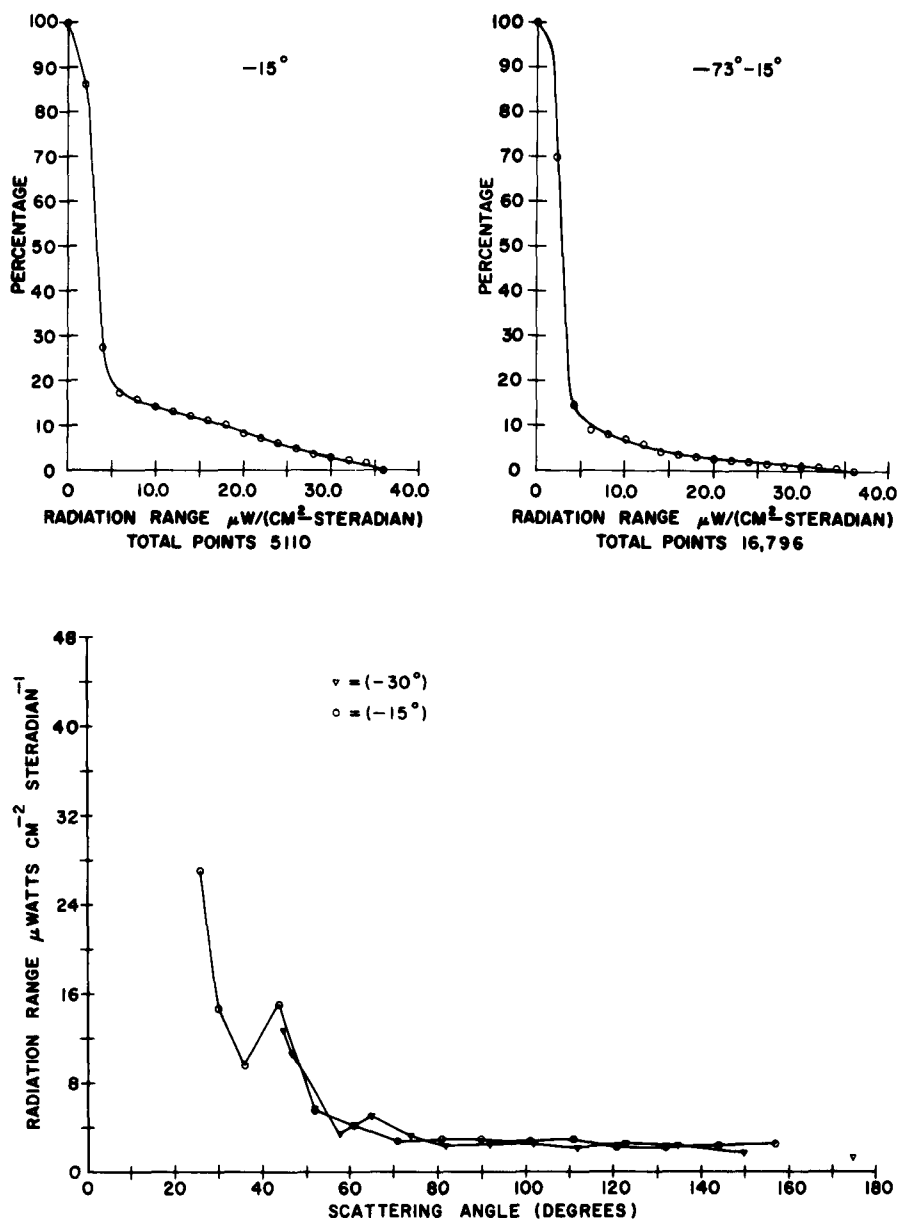
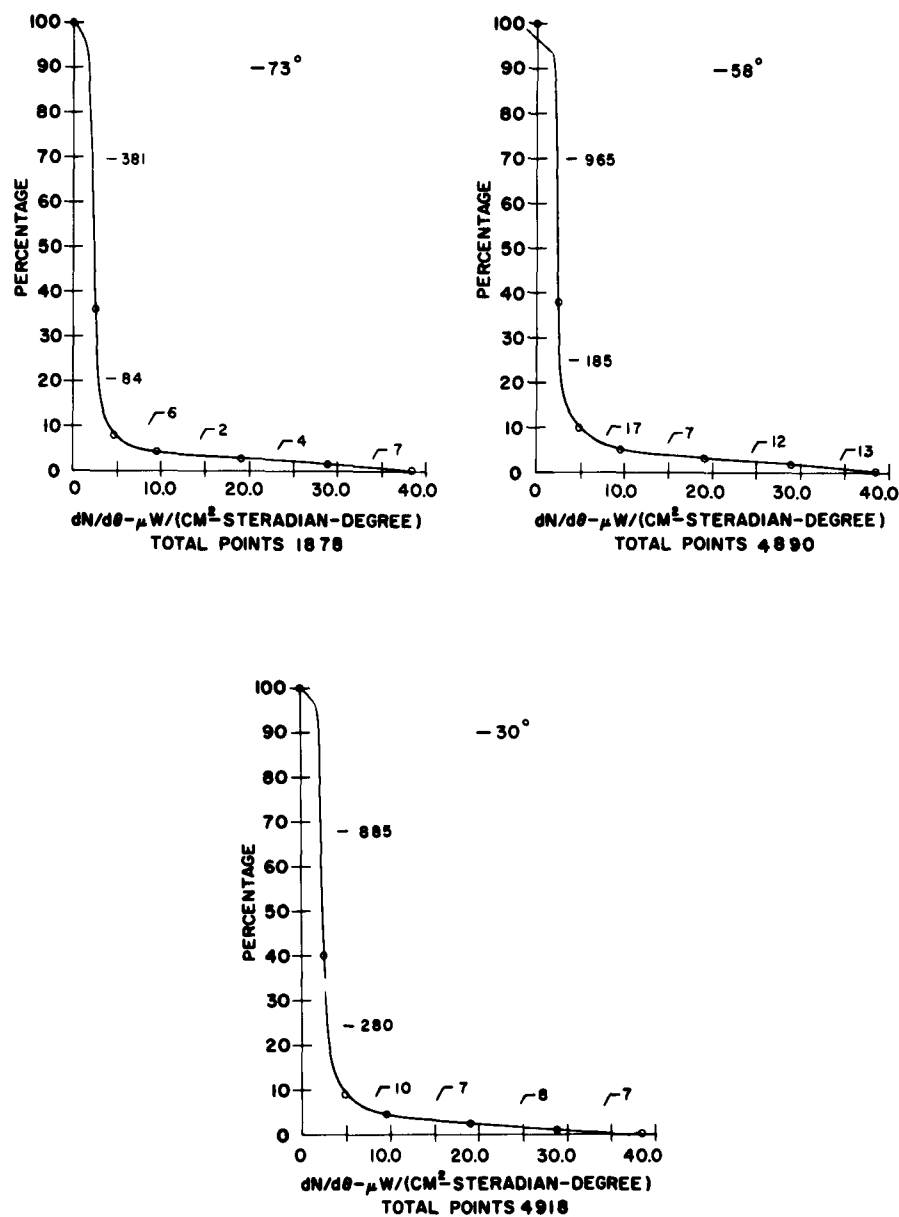


Figure 11 (cont.)



Distribution of IR $dN/d\theta$ with Elevation
 Filter No. 1 7:35-7:40 M.S.T.
 Altitude 31.1 km

Figure 12

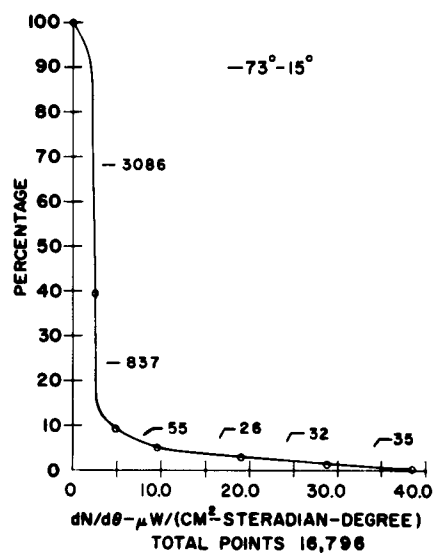
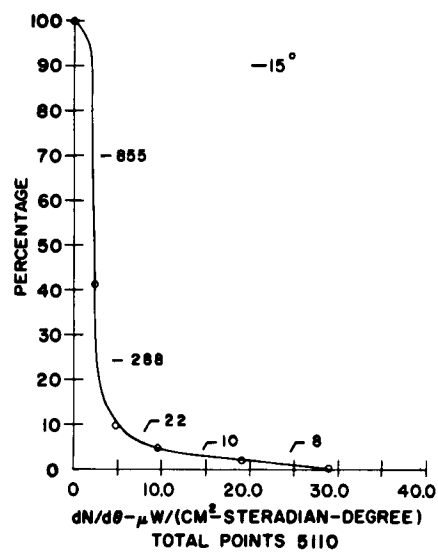
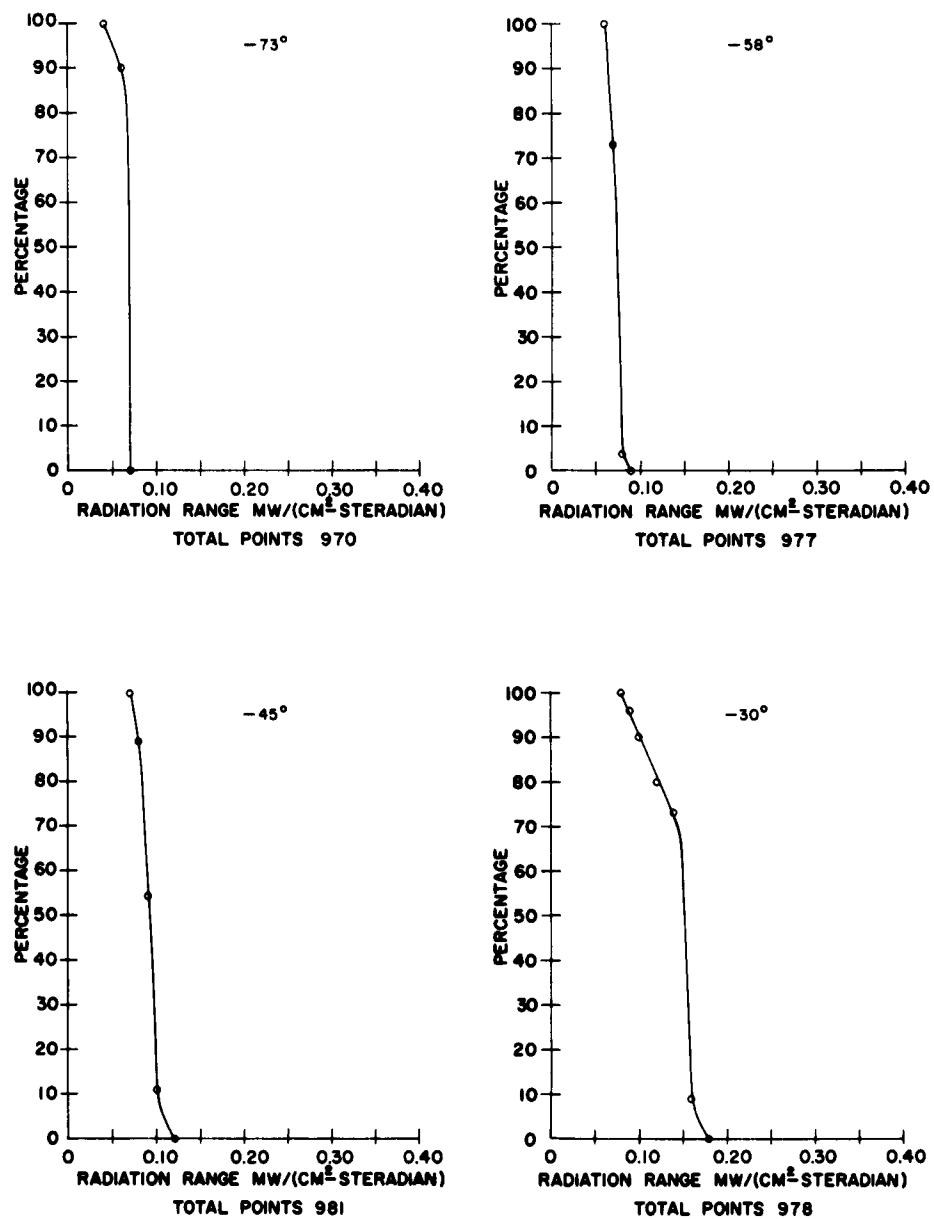


Figure 12 (cont.)



Distribution of UV Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 10 7:05-7:15 M. S. T.
 Altitude 23.8 km

Figure 13

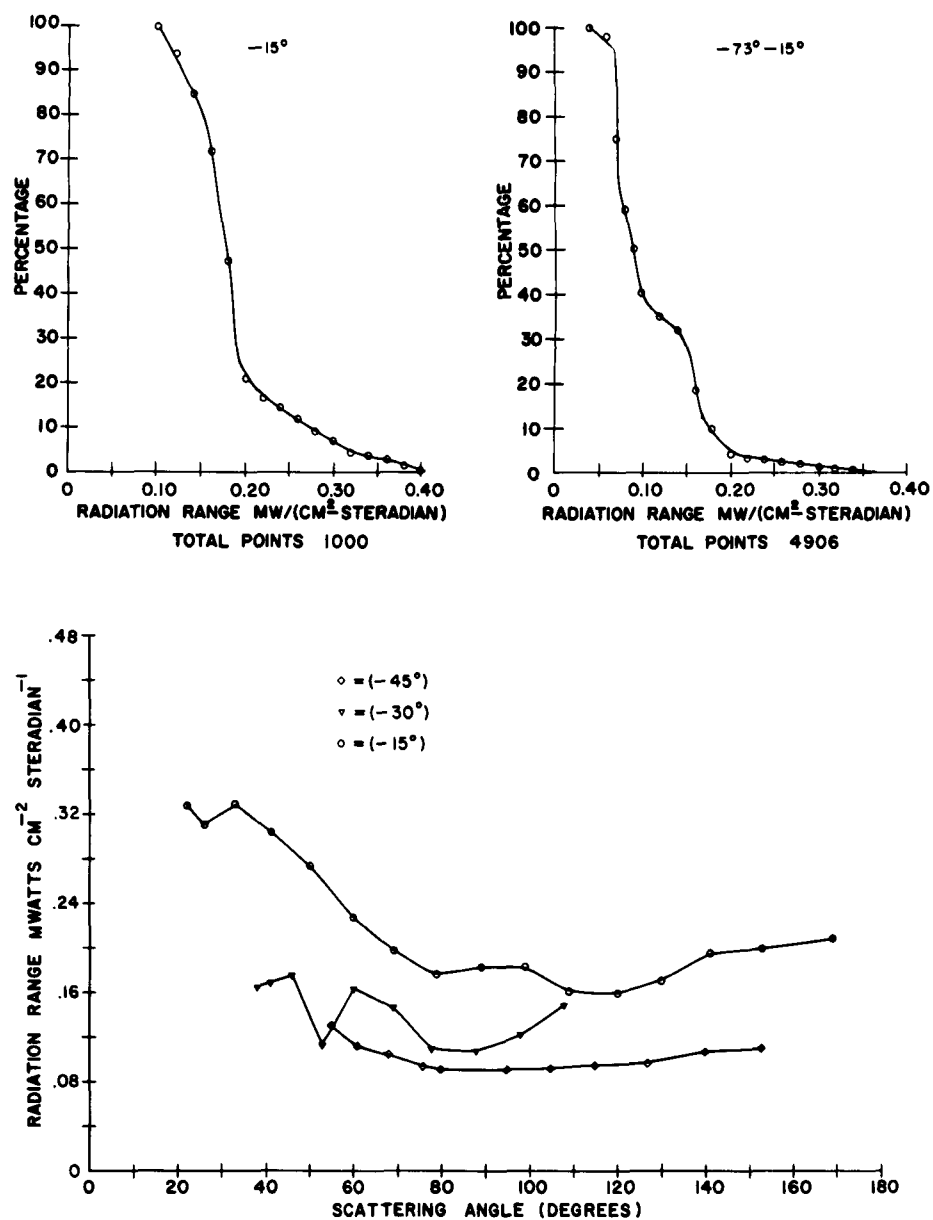
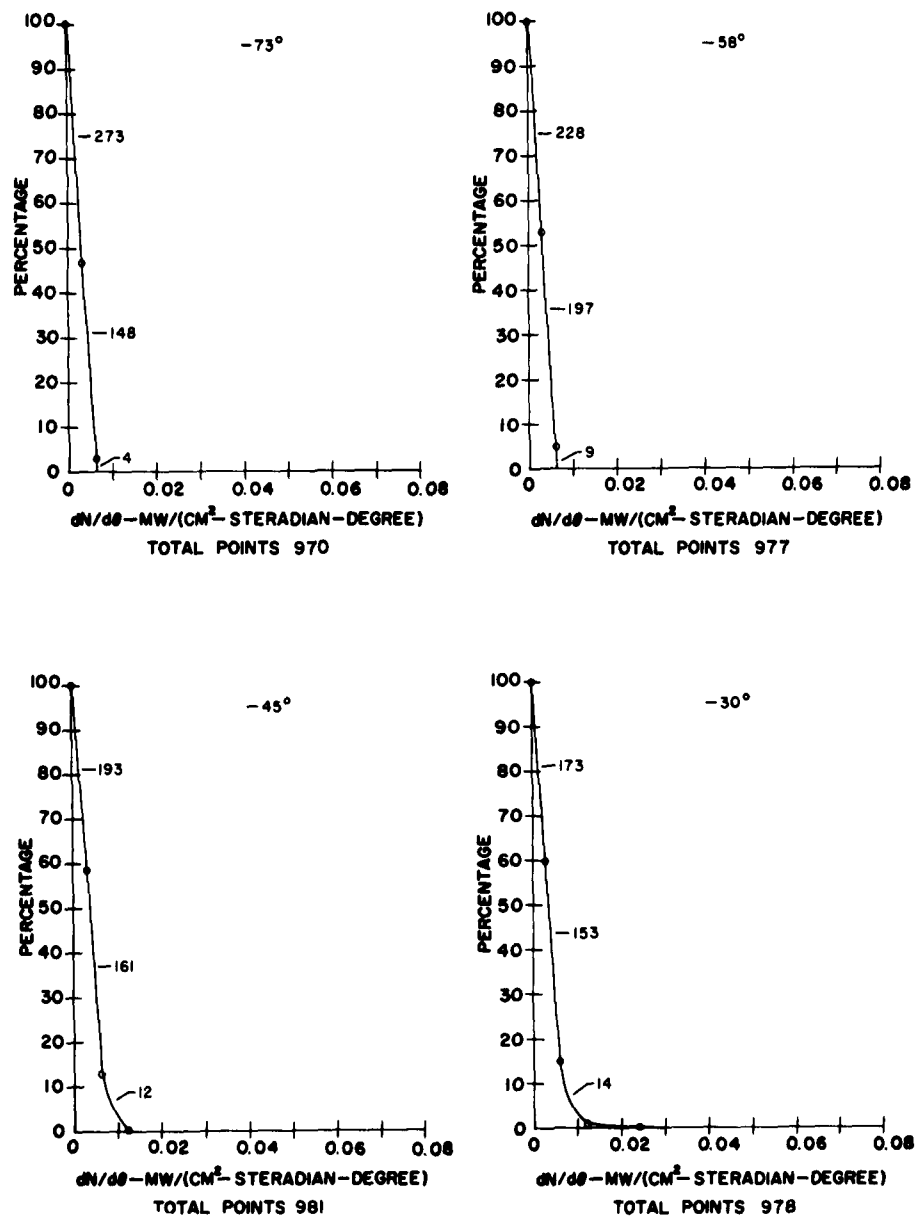


Figure 13 (cont.)



Distribution of UV $dN/d\theta$ with Elevation
 Filter No. 10 7:05-7:15 M.S.T.
 Altitude 23.8 km

Figure 14

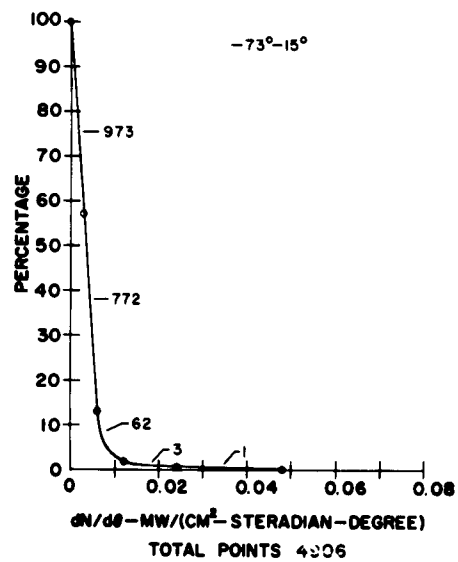
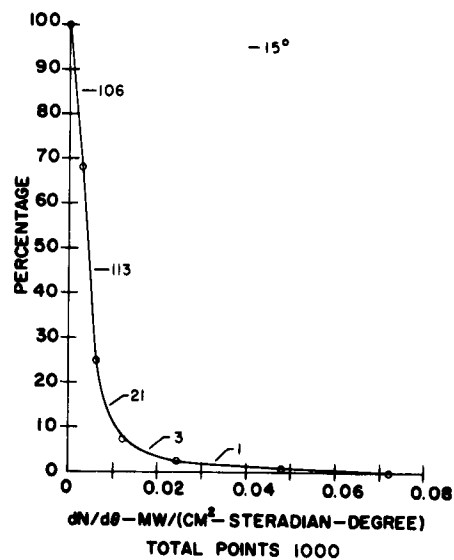
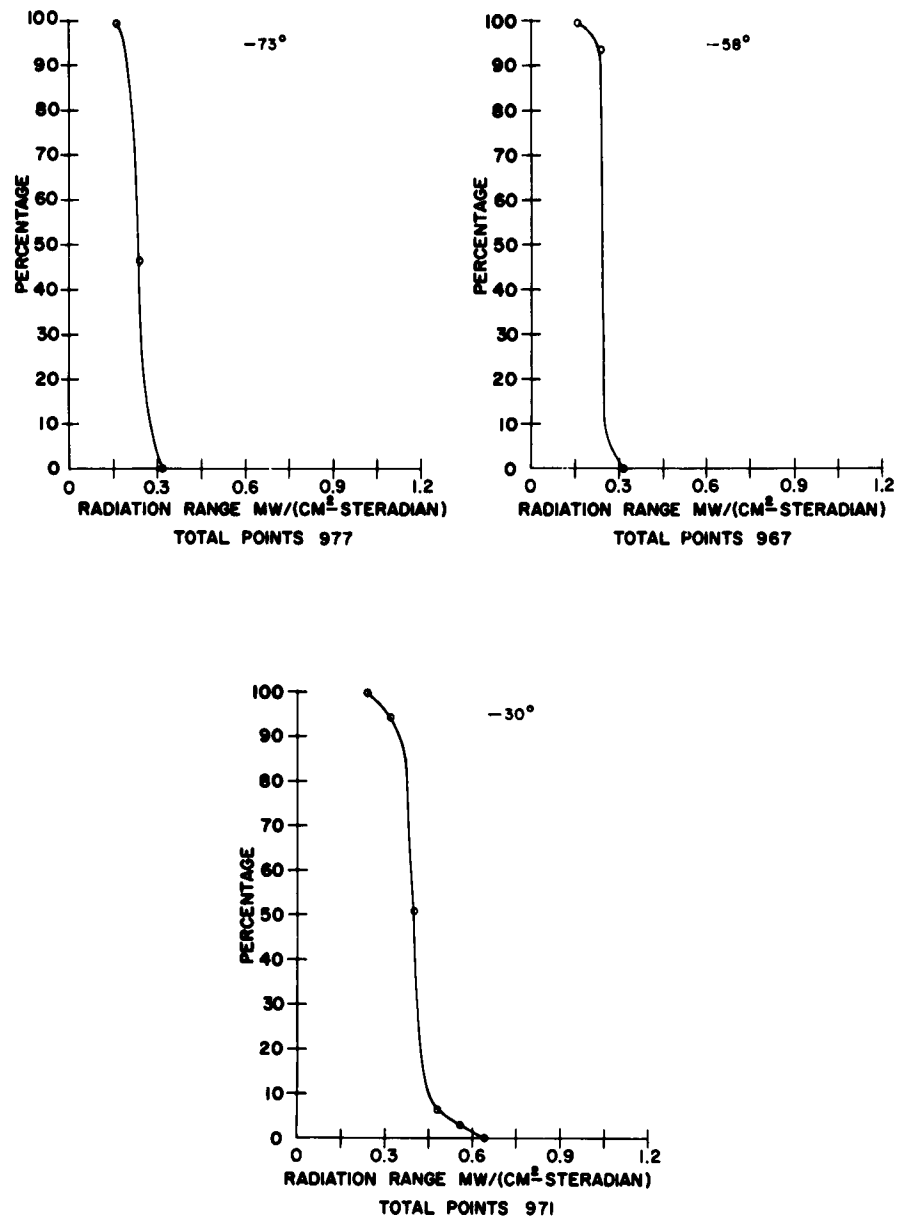


Figure 14 (cont.)



Distribution of UV Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 9 7:15-7:25 M.S.T.
 Altitude 26.2 km

Figure 15

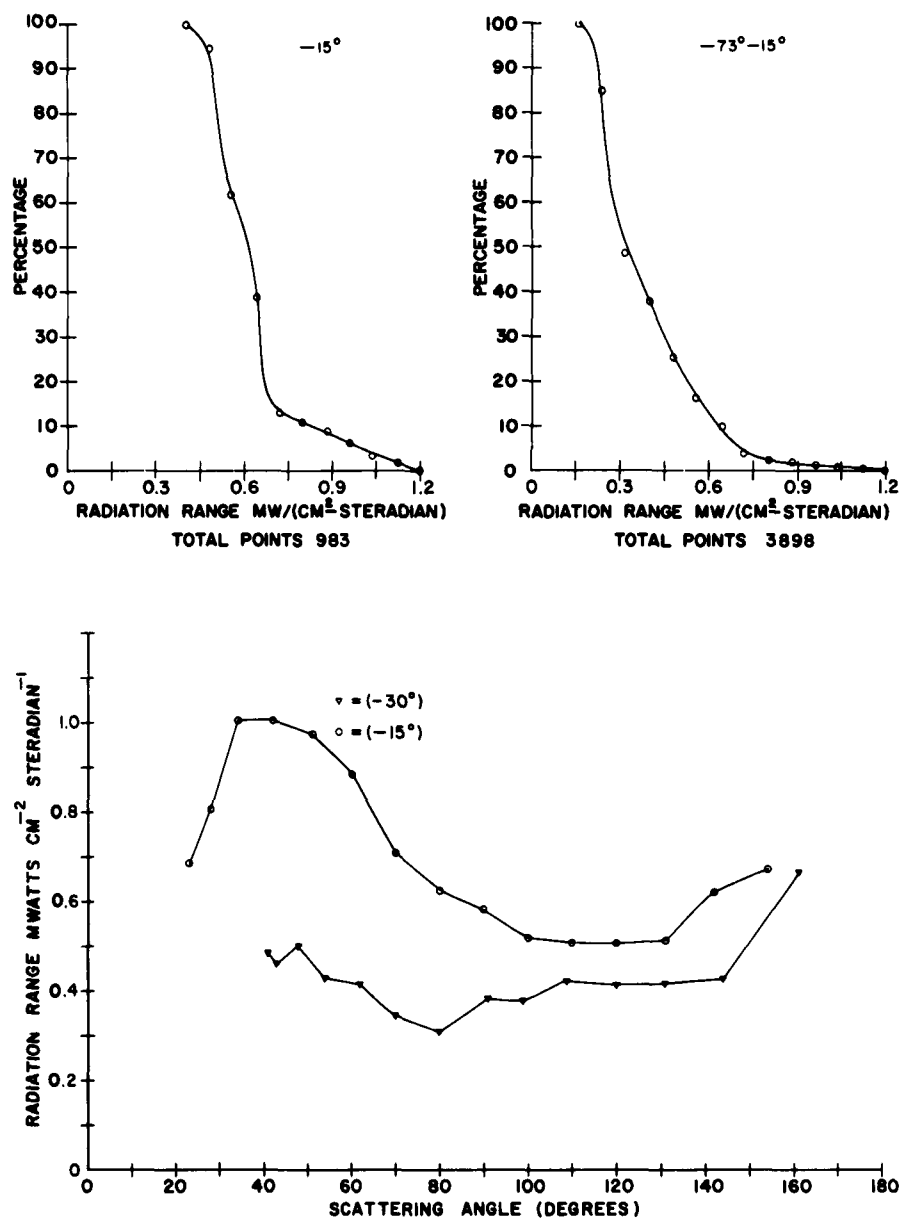
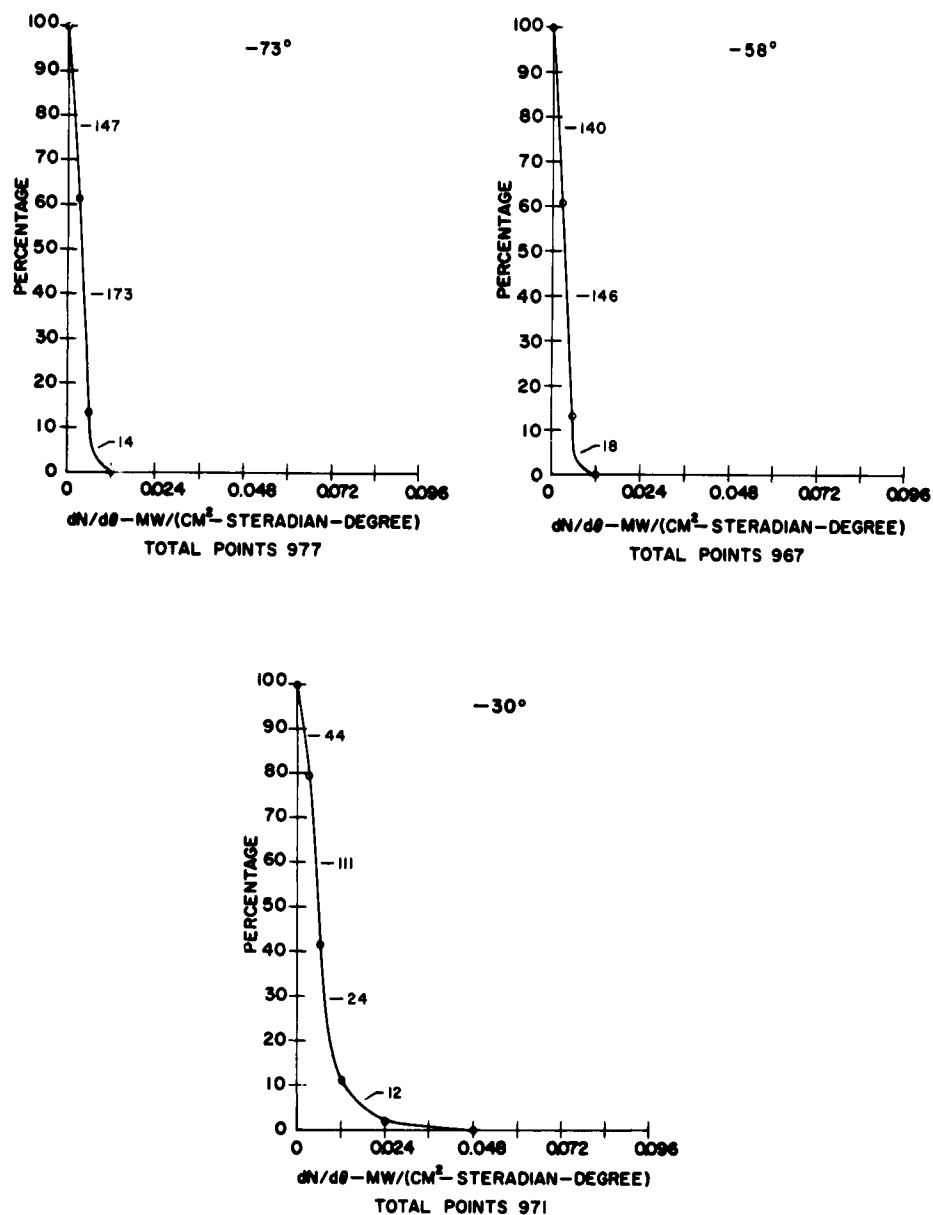


Figure 15 (cont.)



Distribution of UV $dN/d\theta$ with Elevation
 Filter No. 9 7:15-7:25 M.S.T.
 Altitude 26.2 km

Figure 16

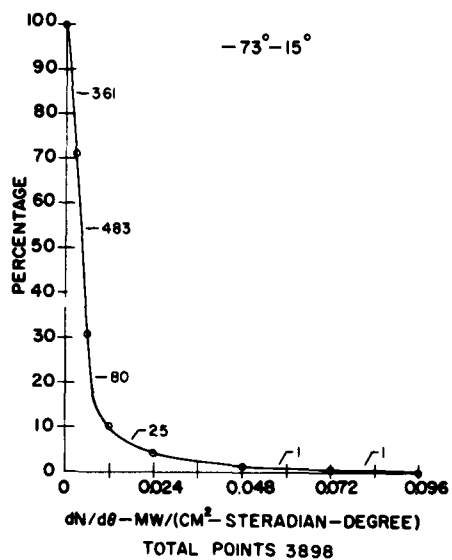
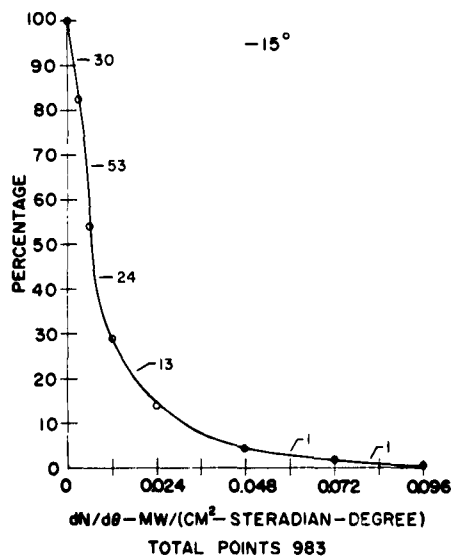
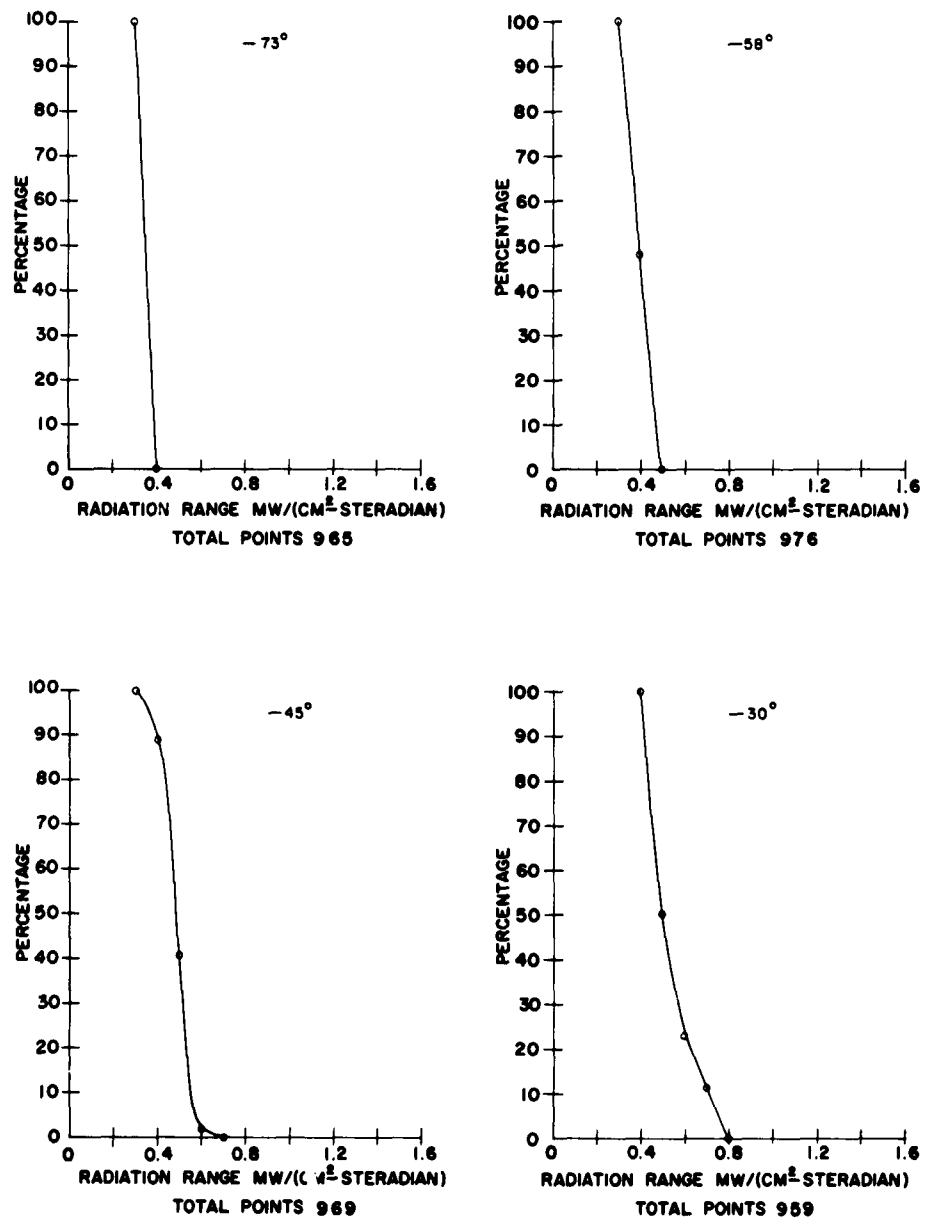


Figure 16 (cont.)



Distribution of UV Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 8 7:25-7:35 M. S. T.
 Altitude 28.7 km

Figure 17

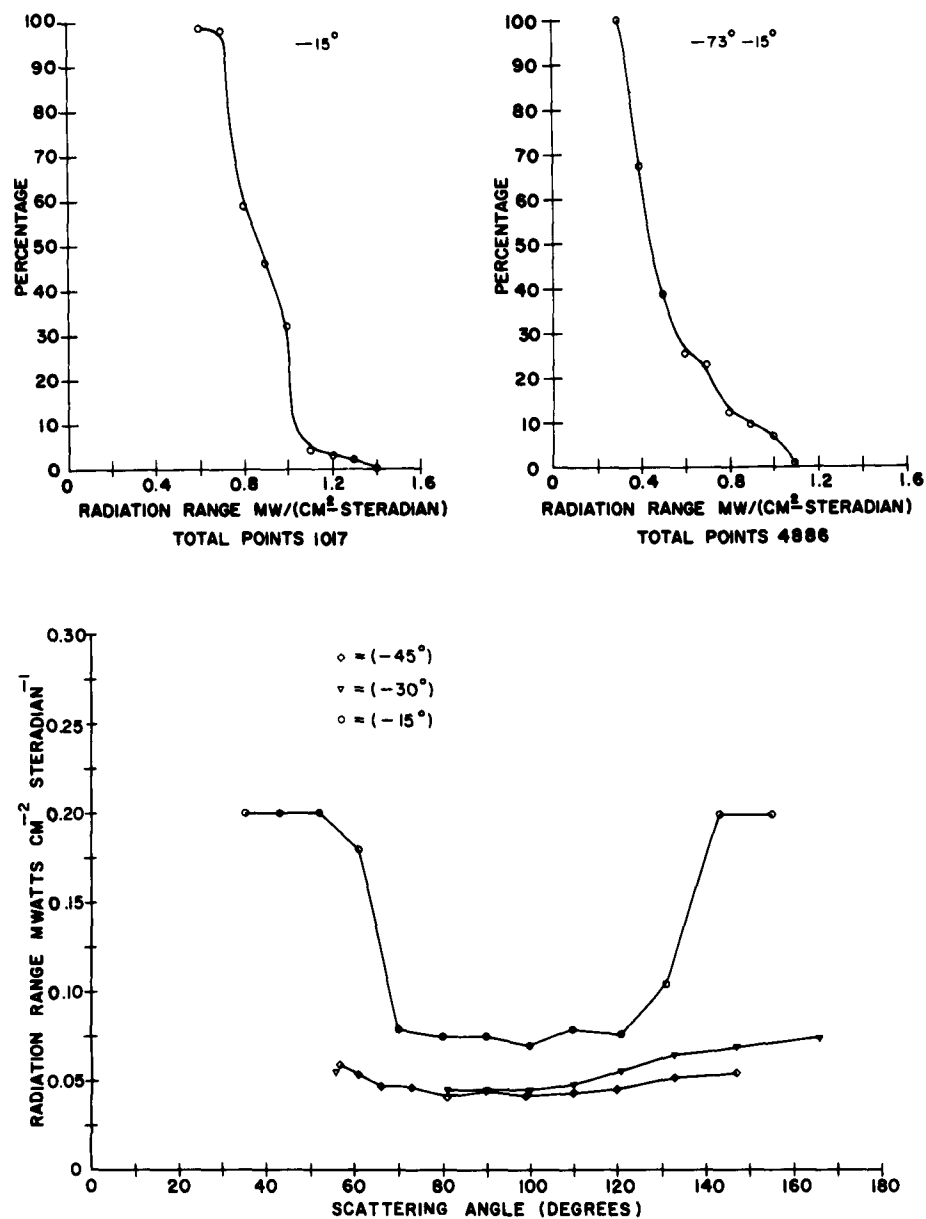
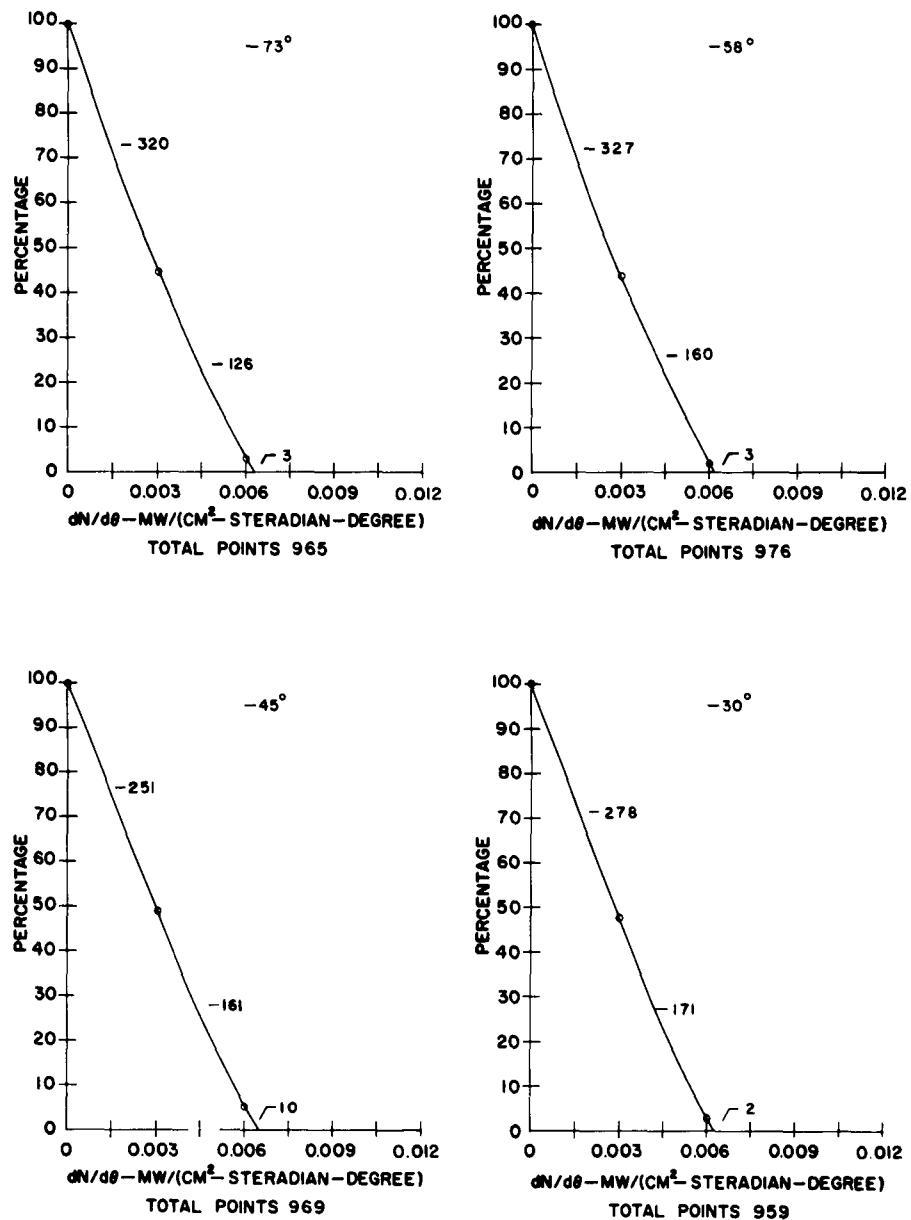


Figure 17 (cont.)



Distribution of UV $dN/d\theta$ with Elevation
 Filter No. 8 7:25-7:35 M. S. T.
 Altitude 28.7 km

Figure 18

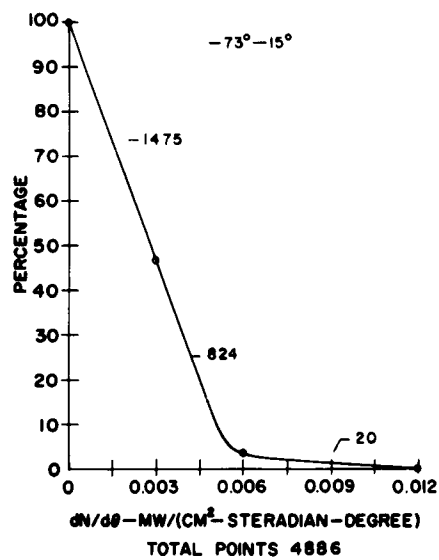
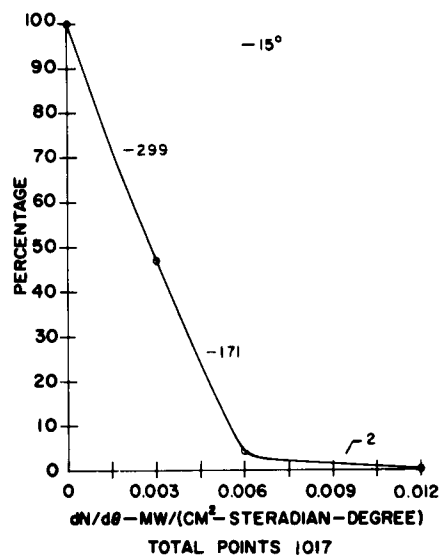
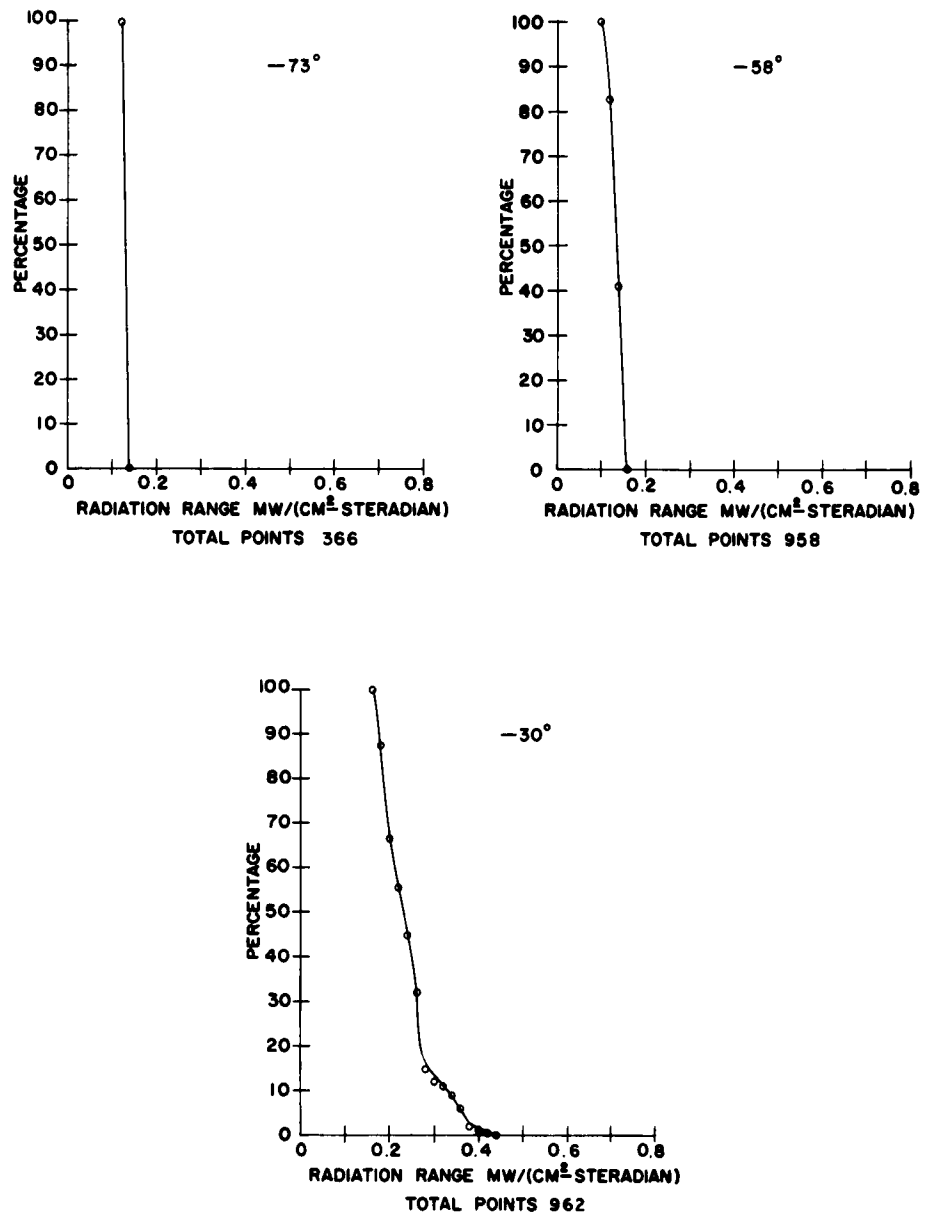


Figure 18 (cont.)



Distribution of UV Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 7 7:35-7:40 M.S.T.
 Altitude 31.1 km

Figure 19

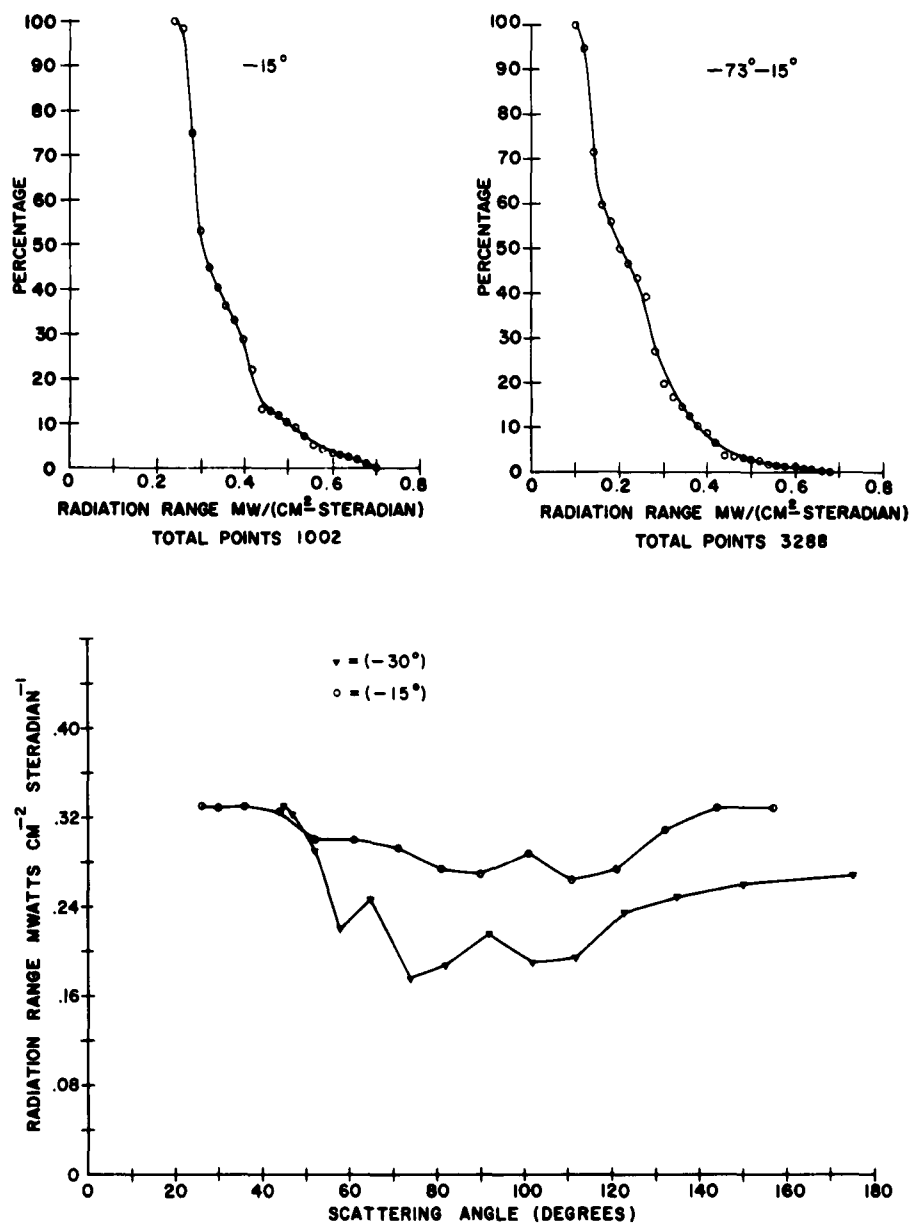
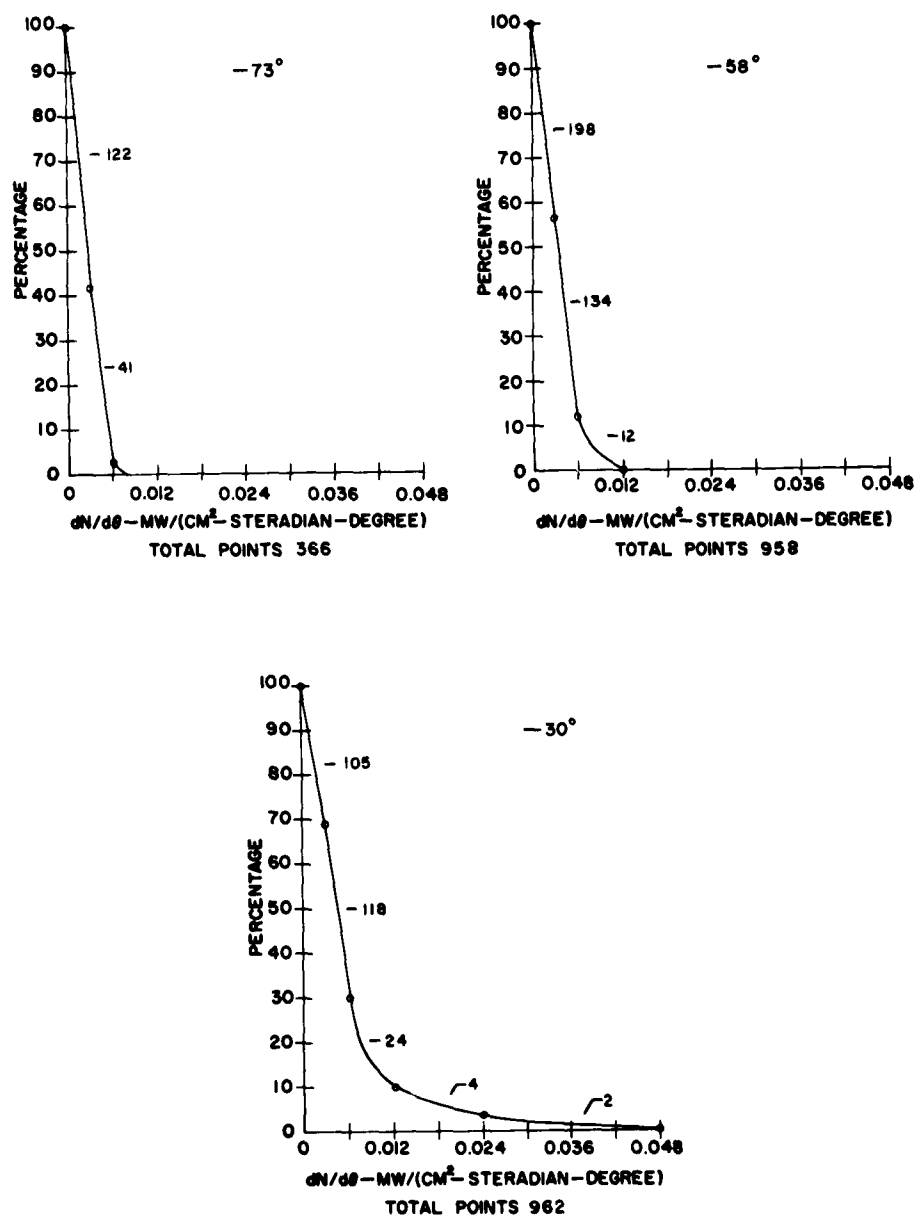


Figure 19 (cont.)



Distribution of UV $dN/d\theta$ with Elevation
 Filter No. 7 7:35-7:40 M.S.T.
 Altitude 31.1 km

Figure 20

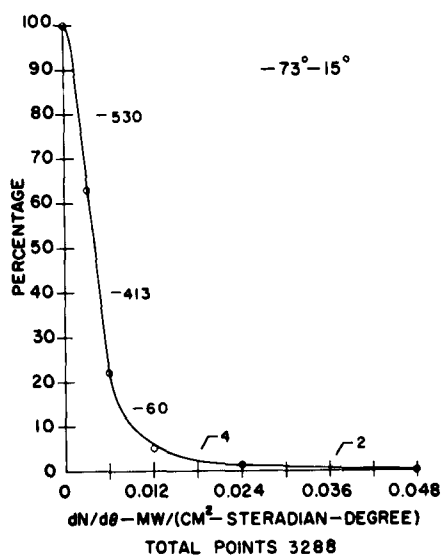
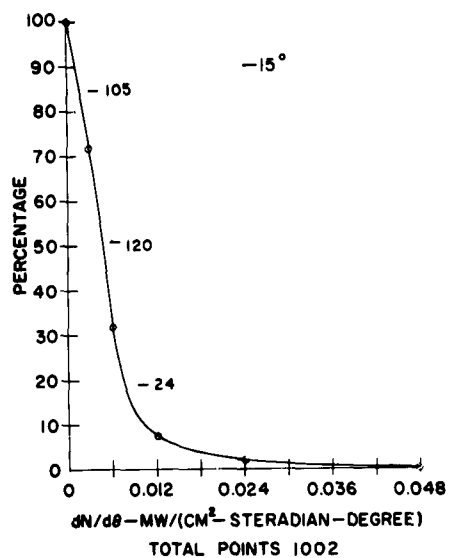
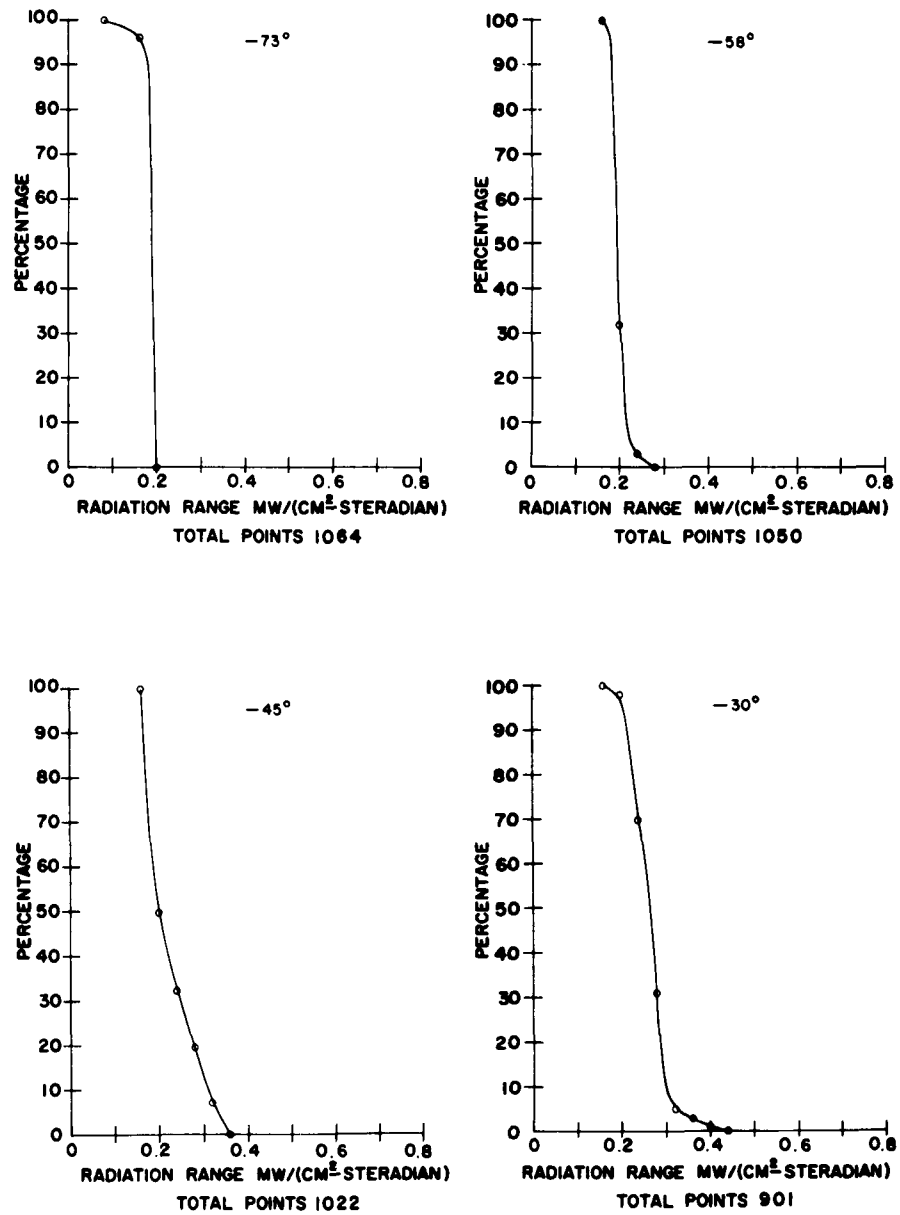


Figure 20 (cont.)



Distribution of UV Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 6 7:40-7:50 M.S.T.
 Altitude 31.1 km

Figure 21

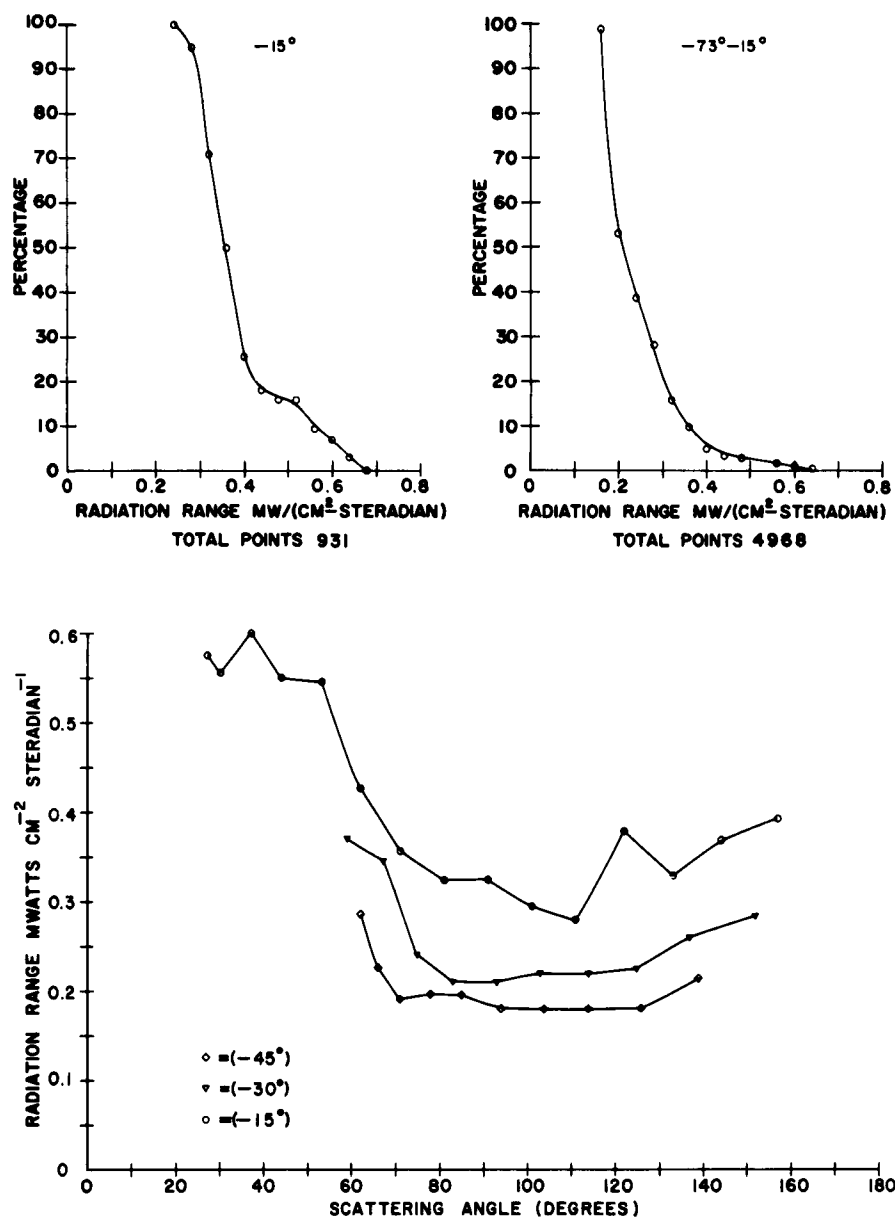
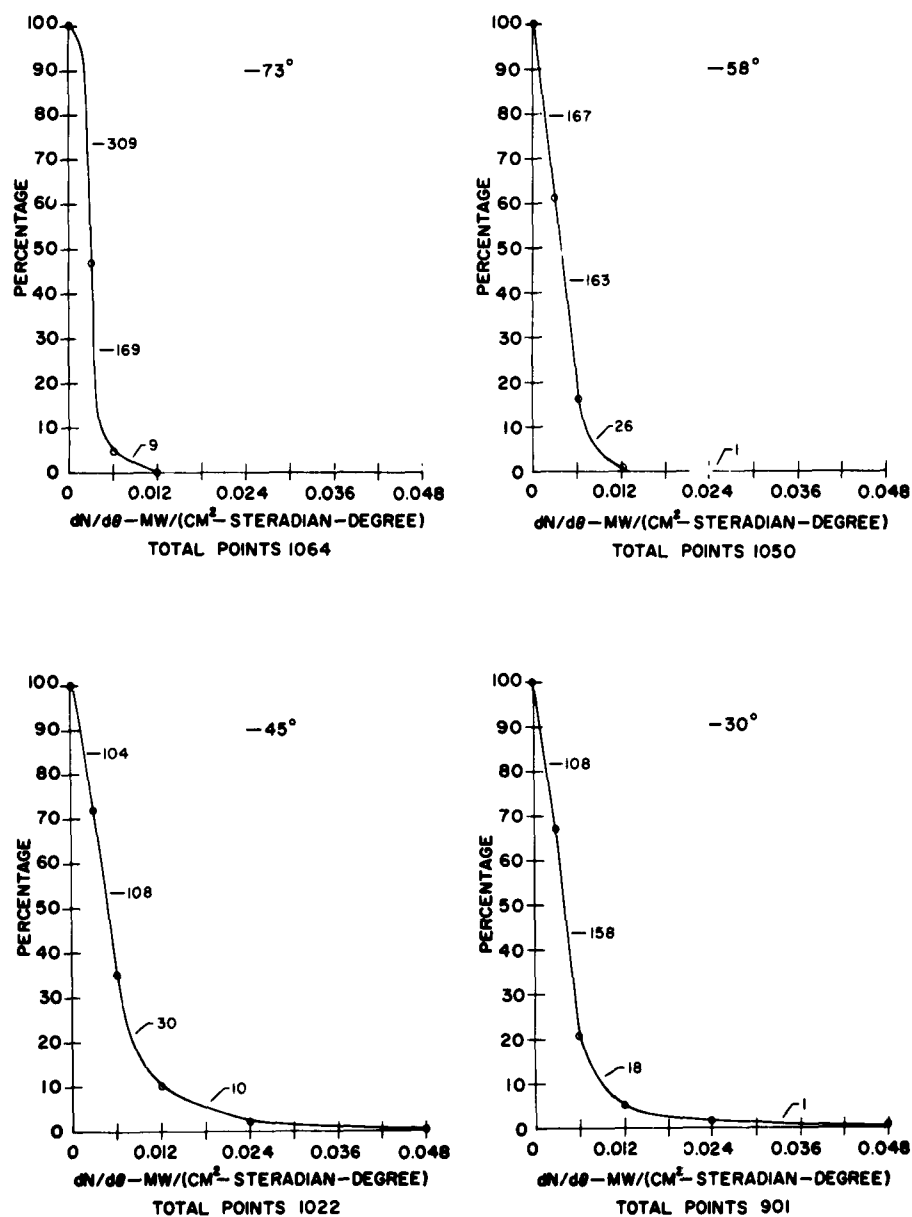


Figure 21 (cont.)



Distribution of UV $dN/d\theta$ with Elevation
 Filter No. 6 7:40-7:50 M. S. T.
 Altitude 31.1 km

Figure 22

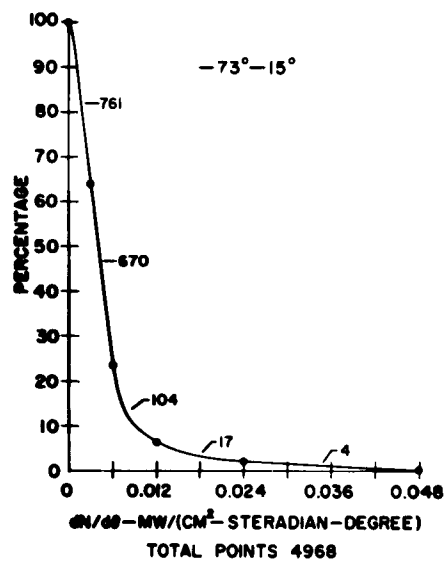
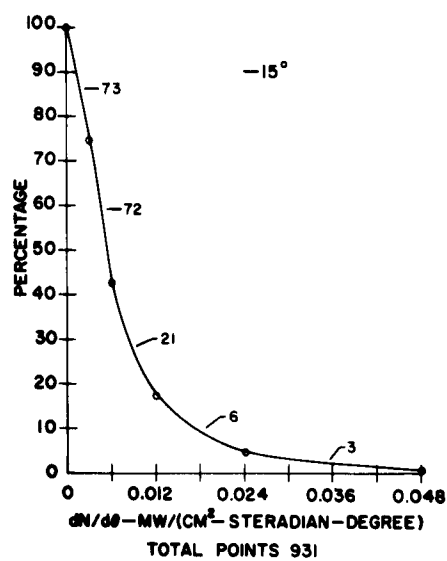
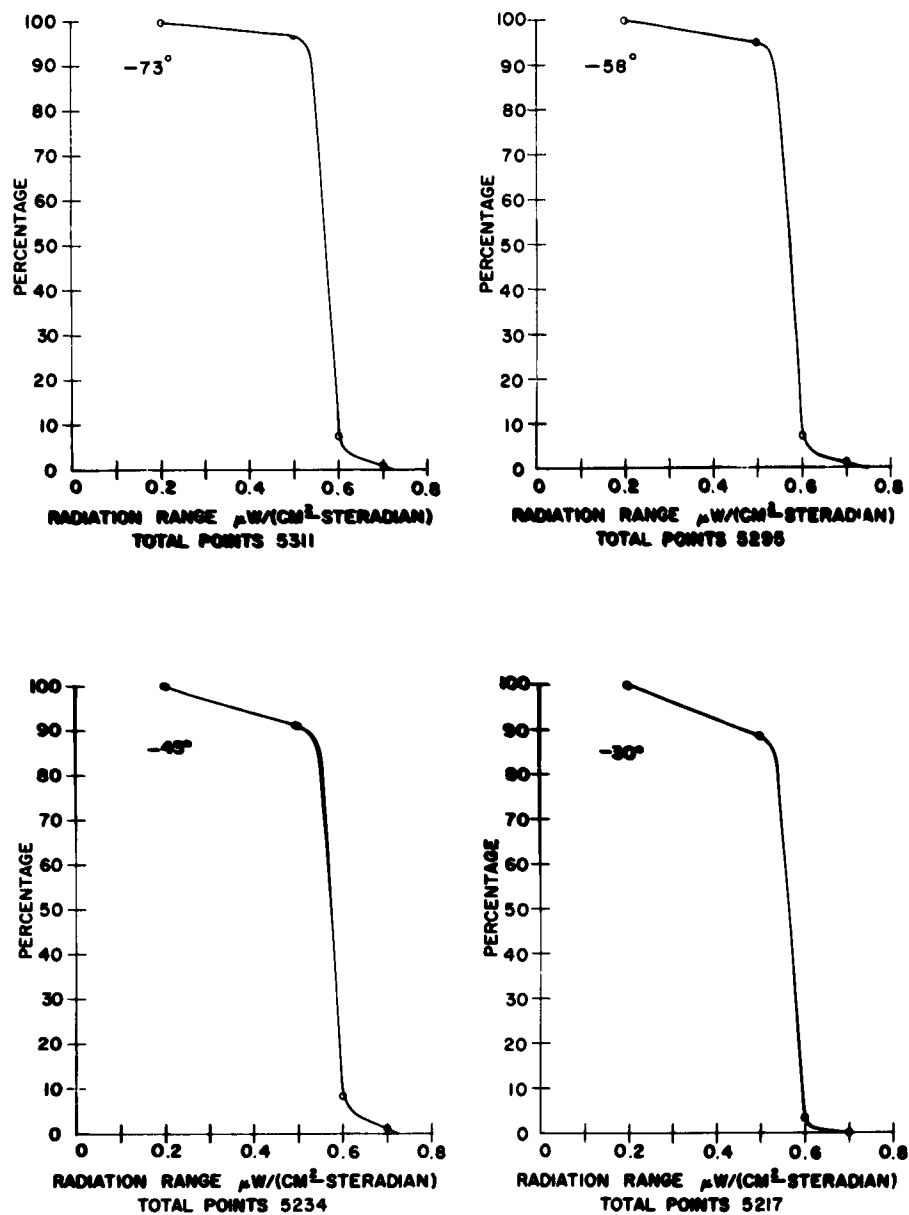


Figure 22 (cont.)



Distribution of IR Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 2 7:20-7:25 M. S. T.
 Altitude 22.4 km

Figure 23

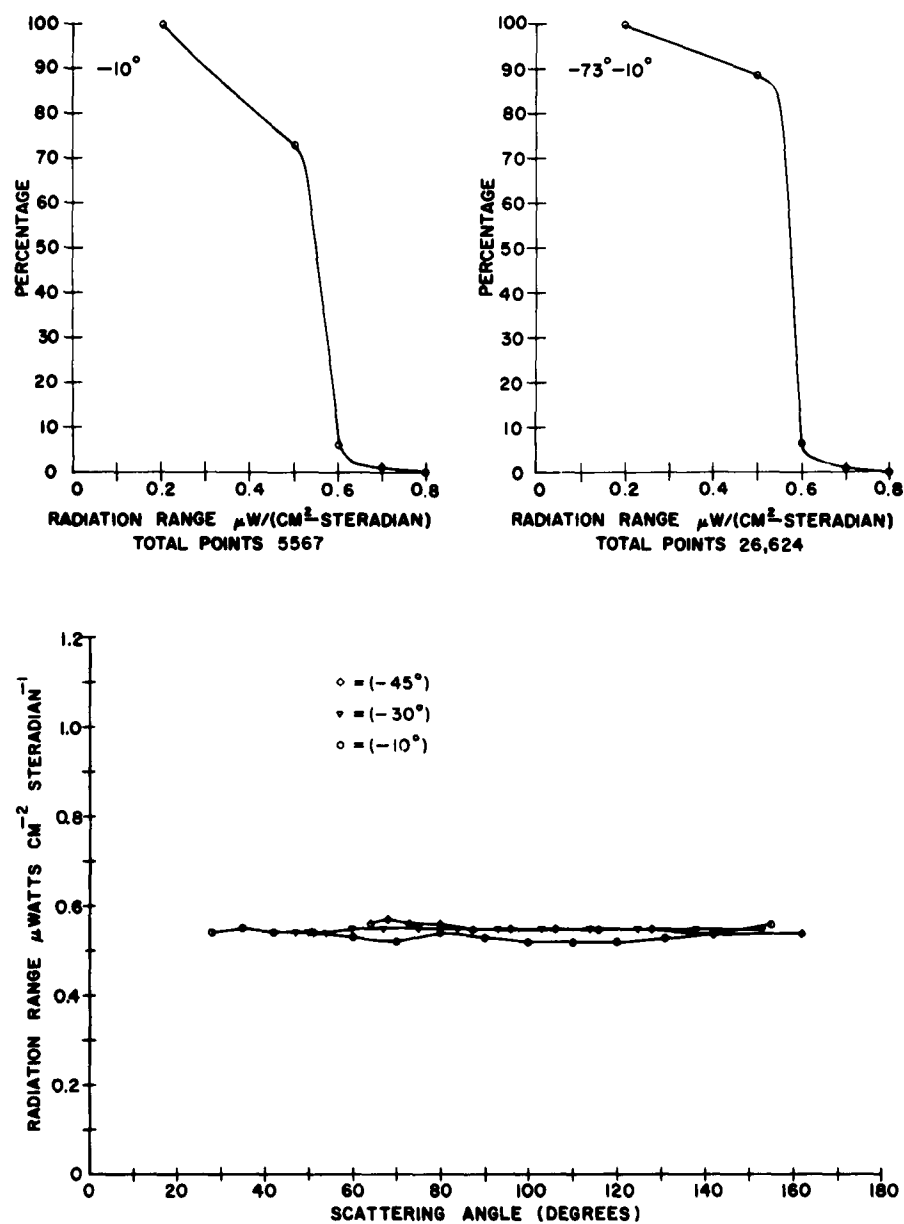
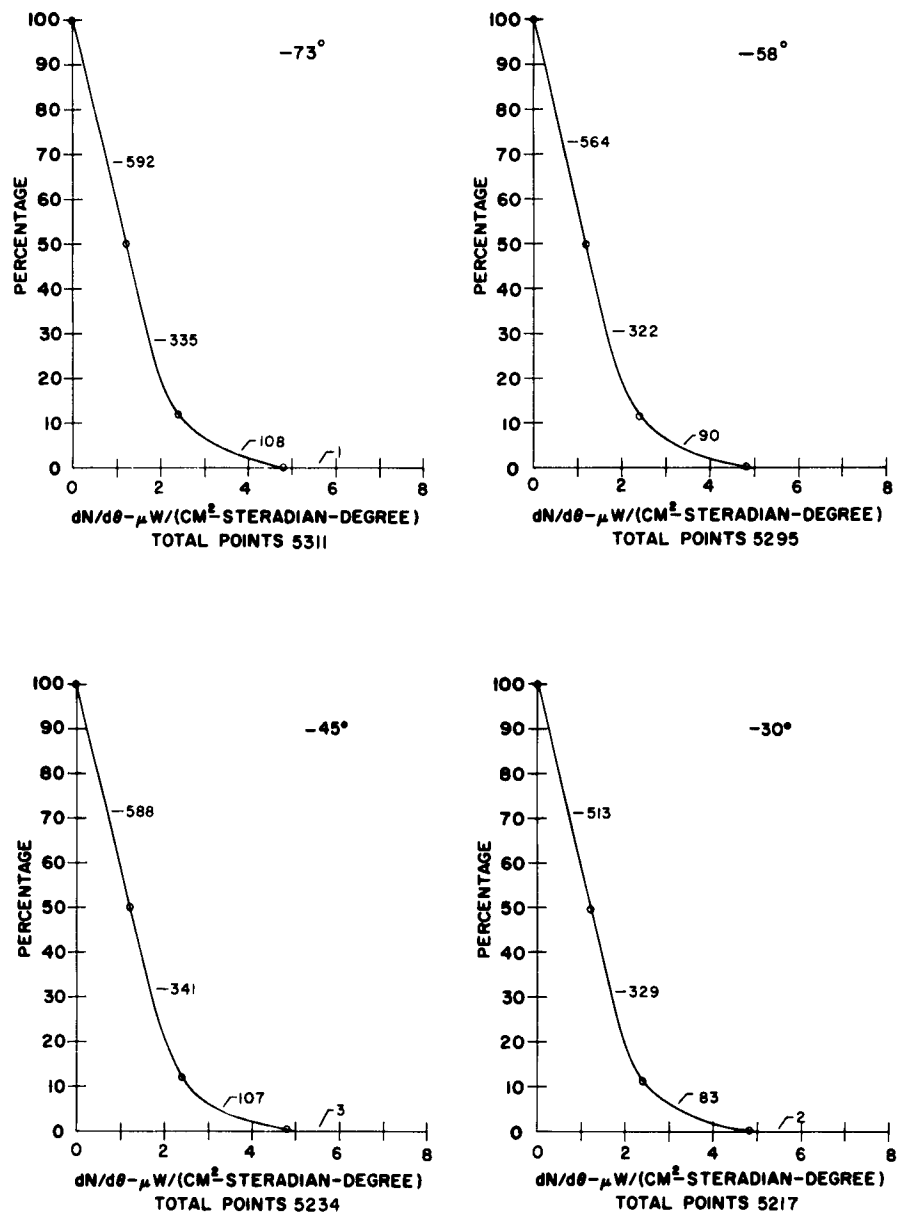


Figure 23 (cont.)



Distribution of IR $dN/d\theta$ with Elevation
 Filter No. 2 7:20-7:25 M.S.T.
 Altitude 22.4 km

Figure 24

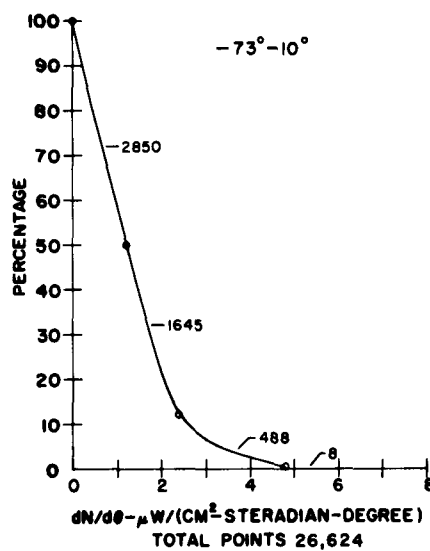
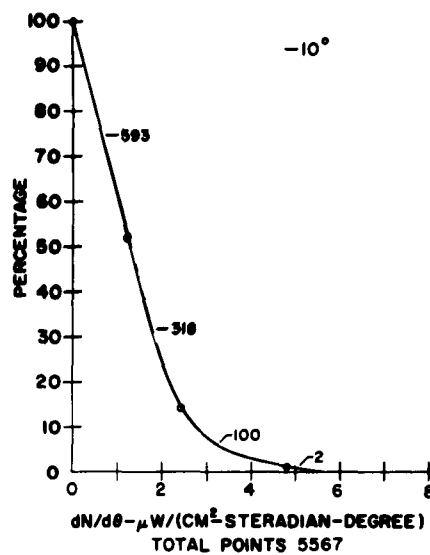
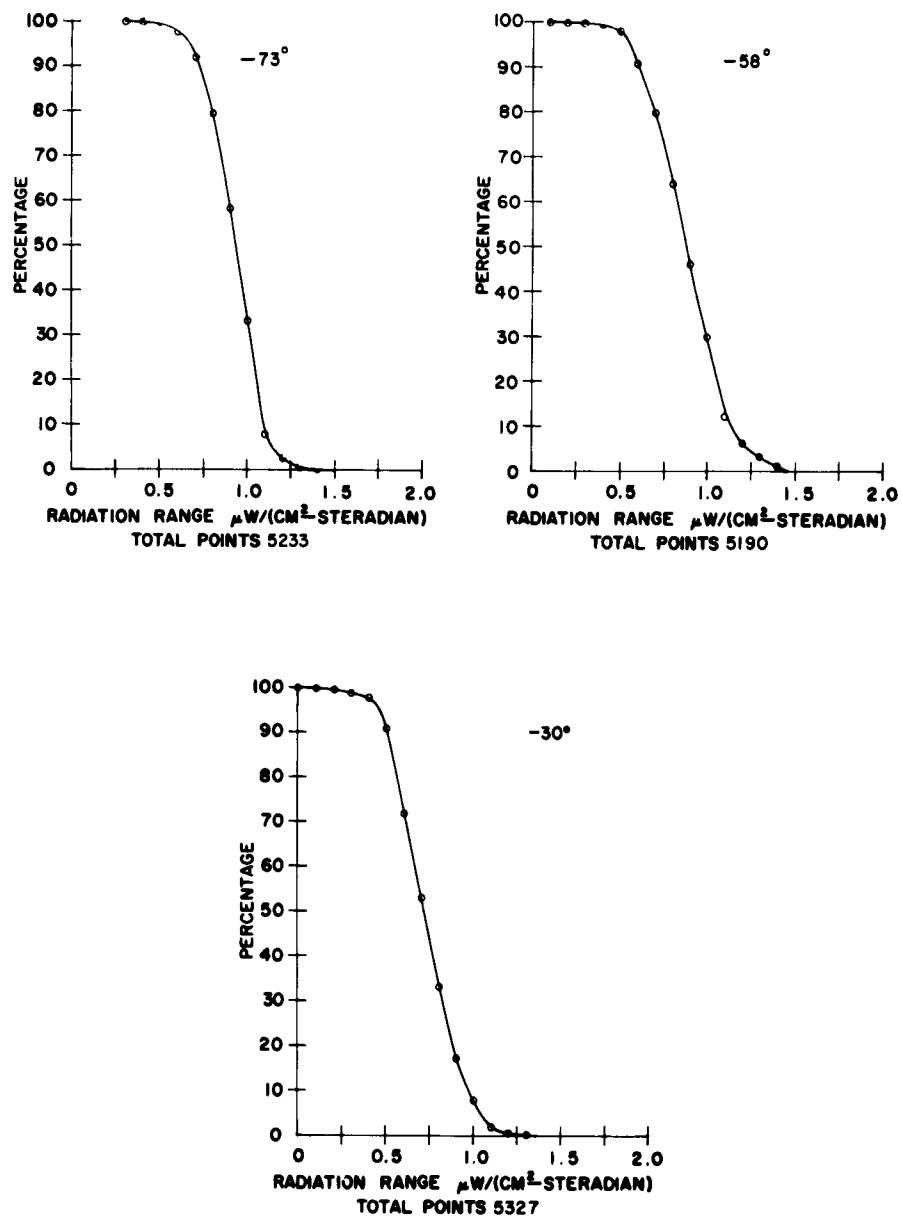


Figure 24 (cont.)



Distribution of IR Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 1 7:25-7:35 M. S. T.
 Altitude 23.7 km

Figure 25

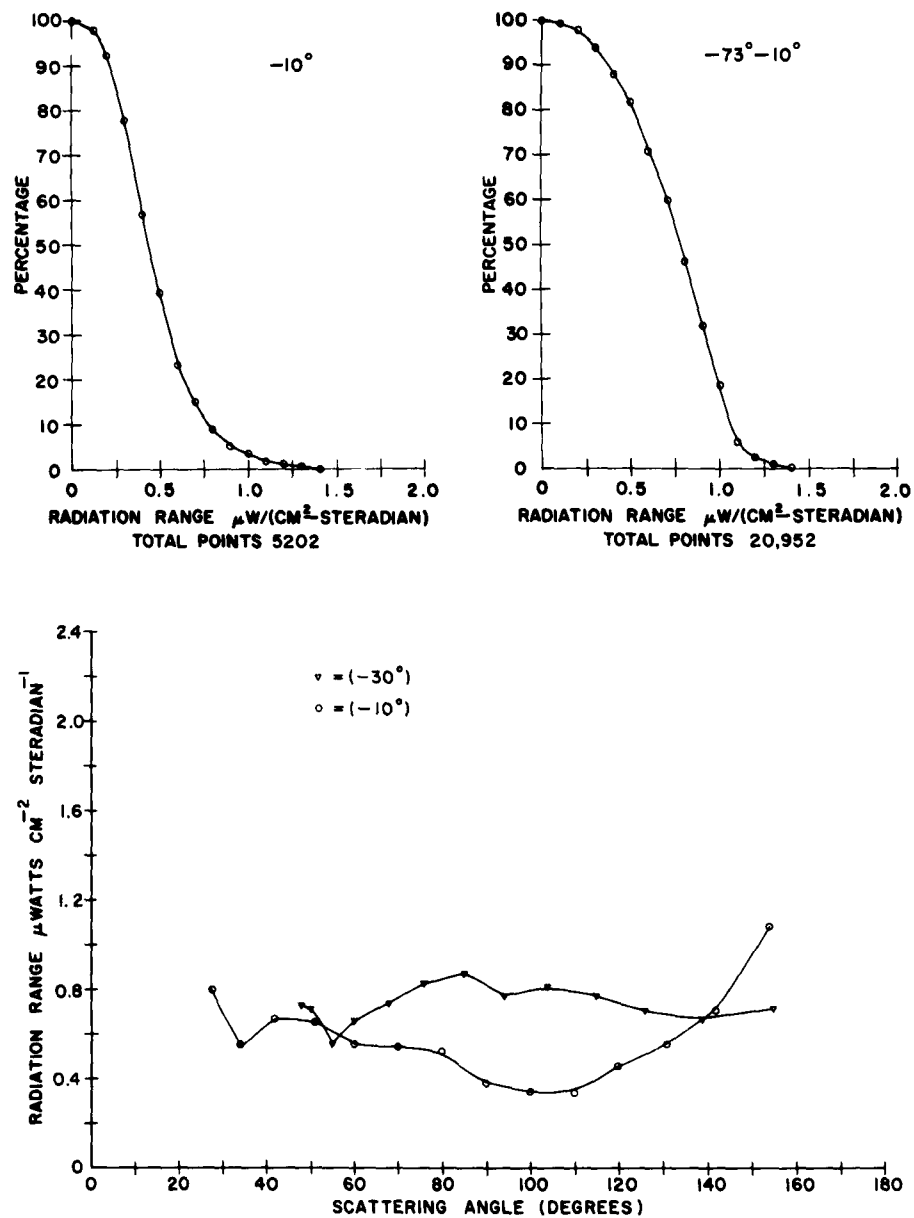
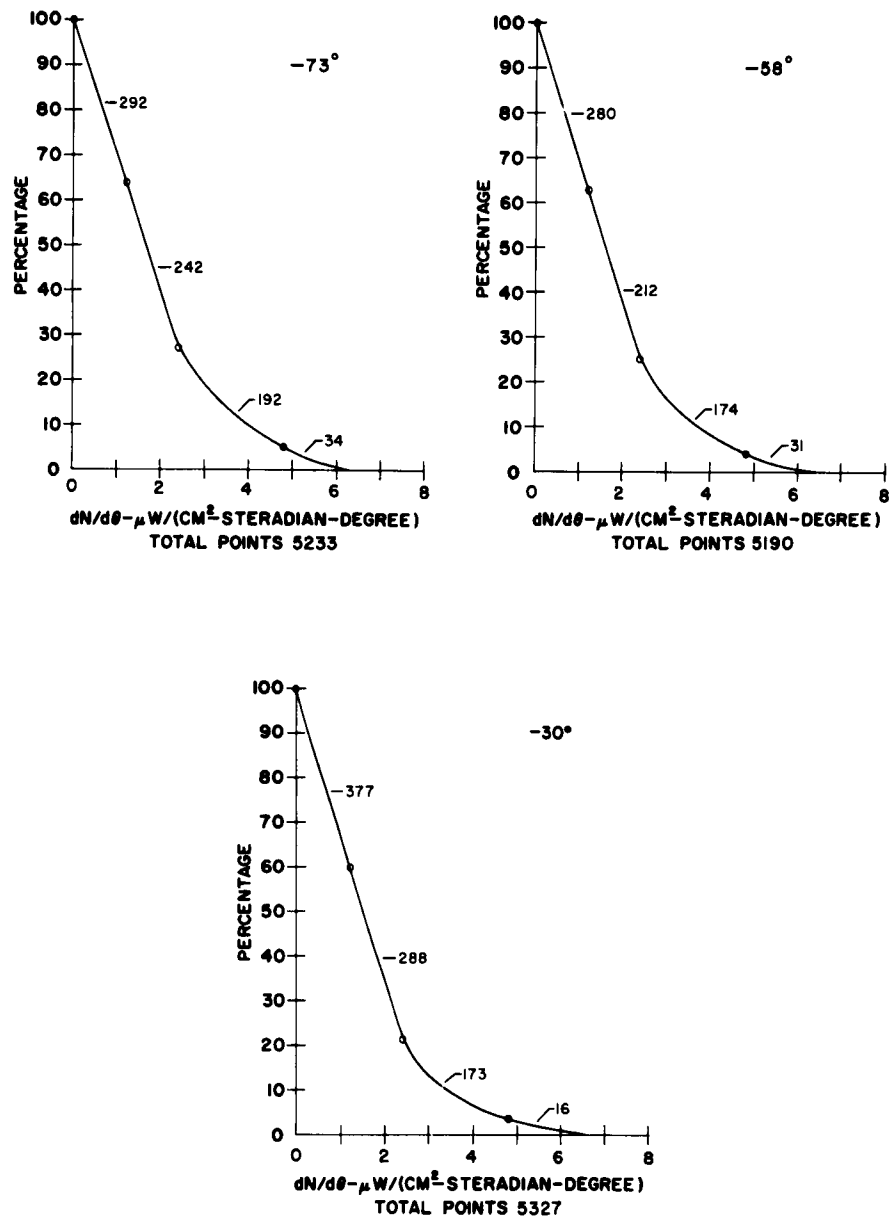


Figure 25 (cont.)



Distribution of IR $dN/d\theta$ with Elevation
 Filter No. 1 7:25-7:35 M.S.T.
 Altitude 23.7 km

Figure 26

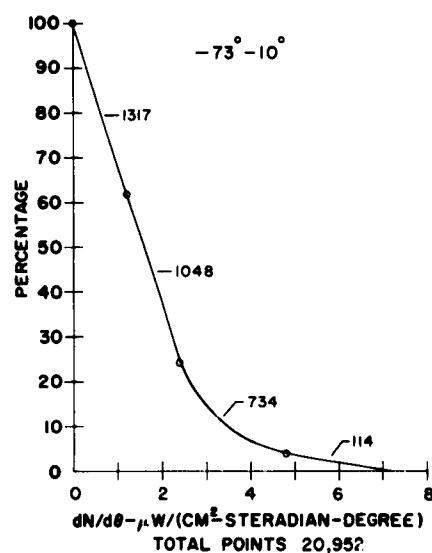
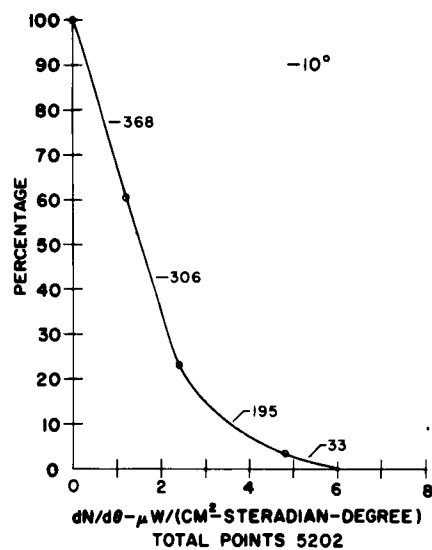
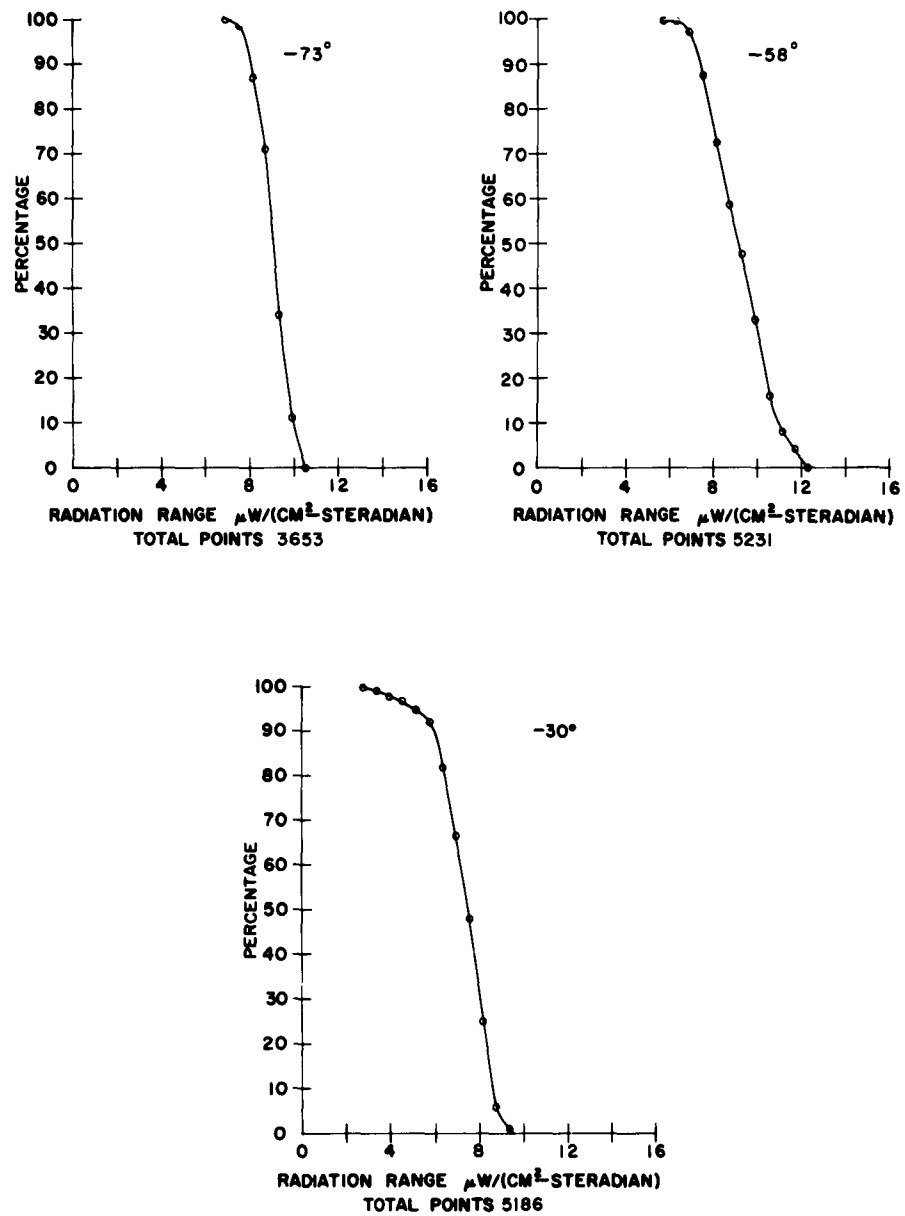


Figure 26 (cont.)



Distribution of IR Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 4 7:45-7:50 M. S. T.
 Altitude 28.3 km

Figure 27

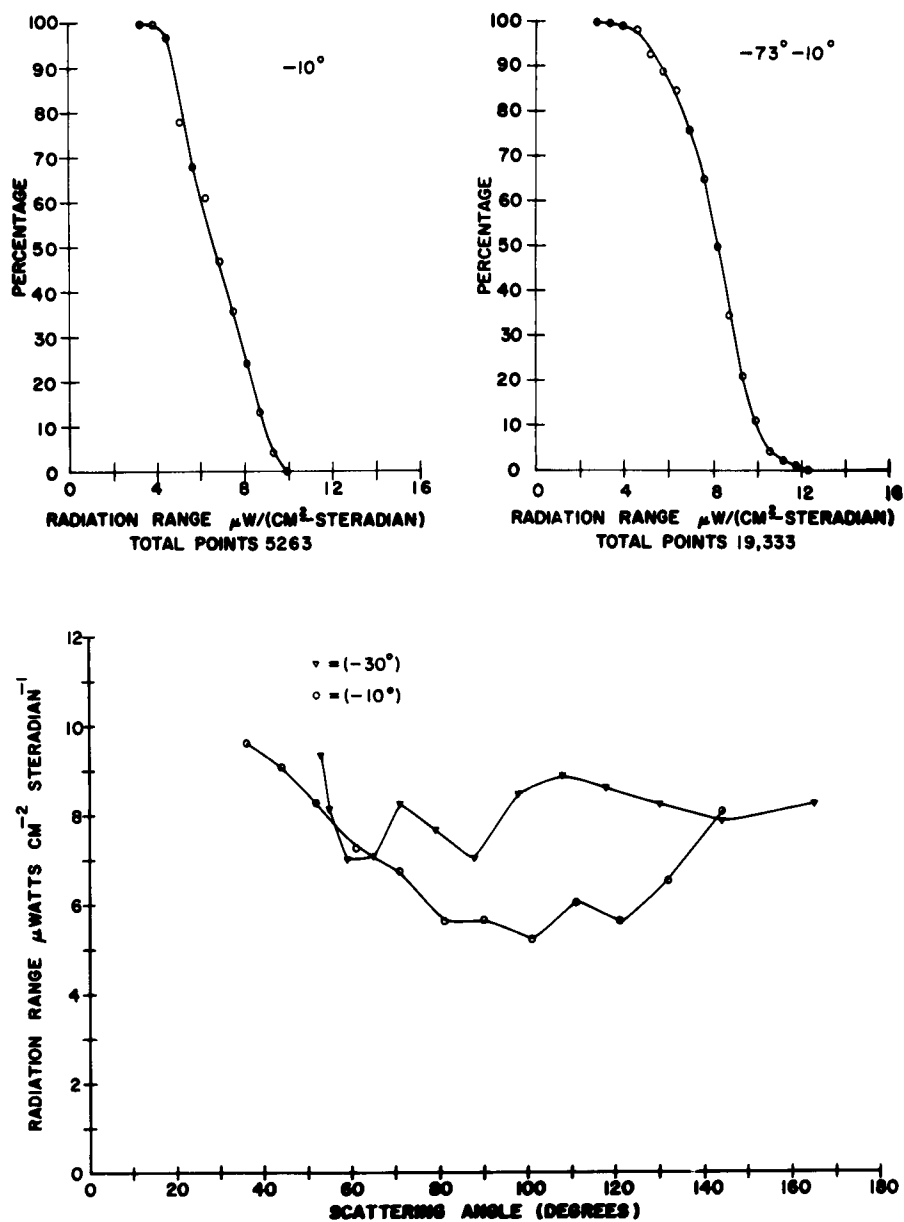
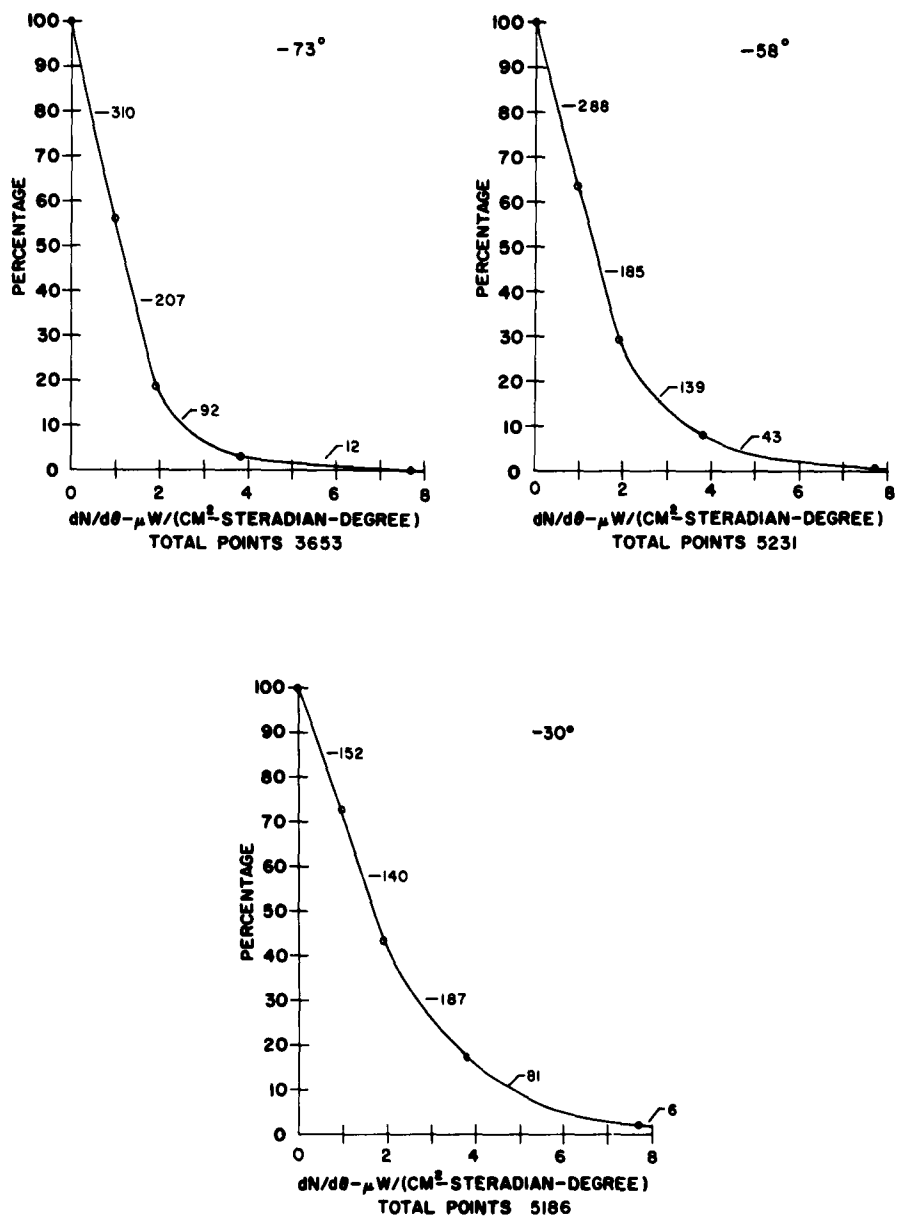


Figure 27 (cont.)



Distribution of IR $dN/d\theta$ with Elevation
 Filter No. 4 7:45-7:50 M.S.T.
 Altitude 28.3 km

Figure 28

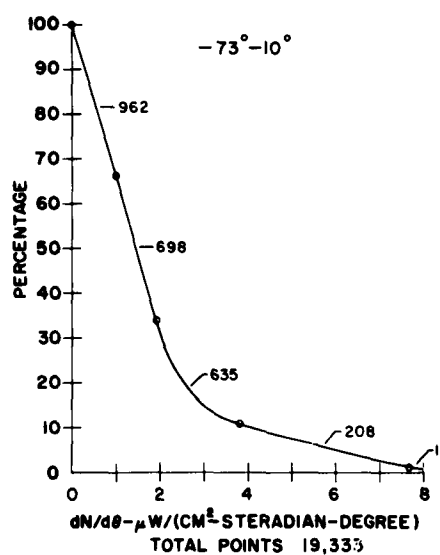
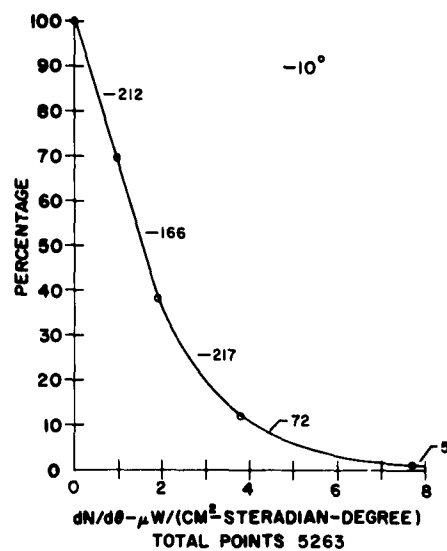
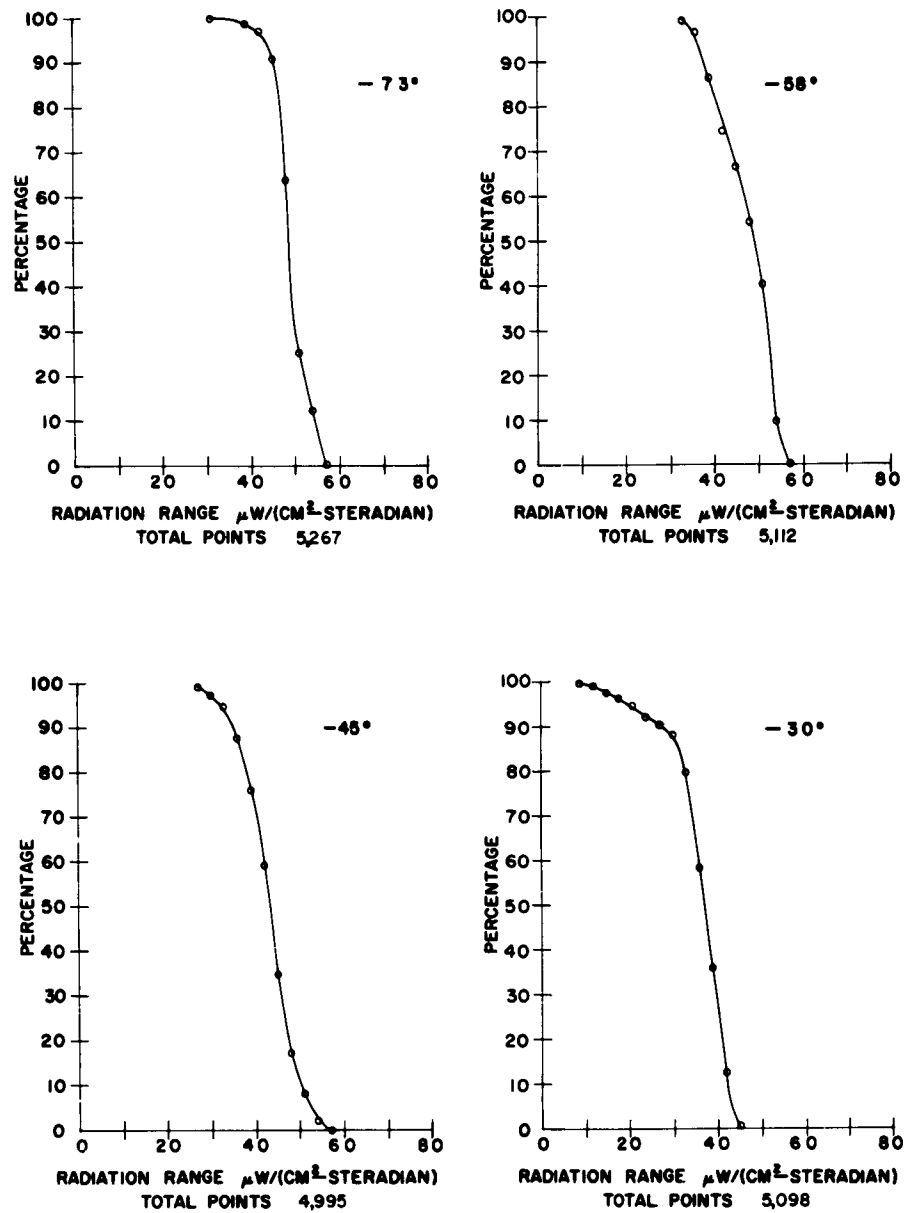


Figure 28 (cont.)



Distribution of IR Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 3 7:50-8:00 M.S.T.
 Altitude 31.1 km

Figure 29

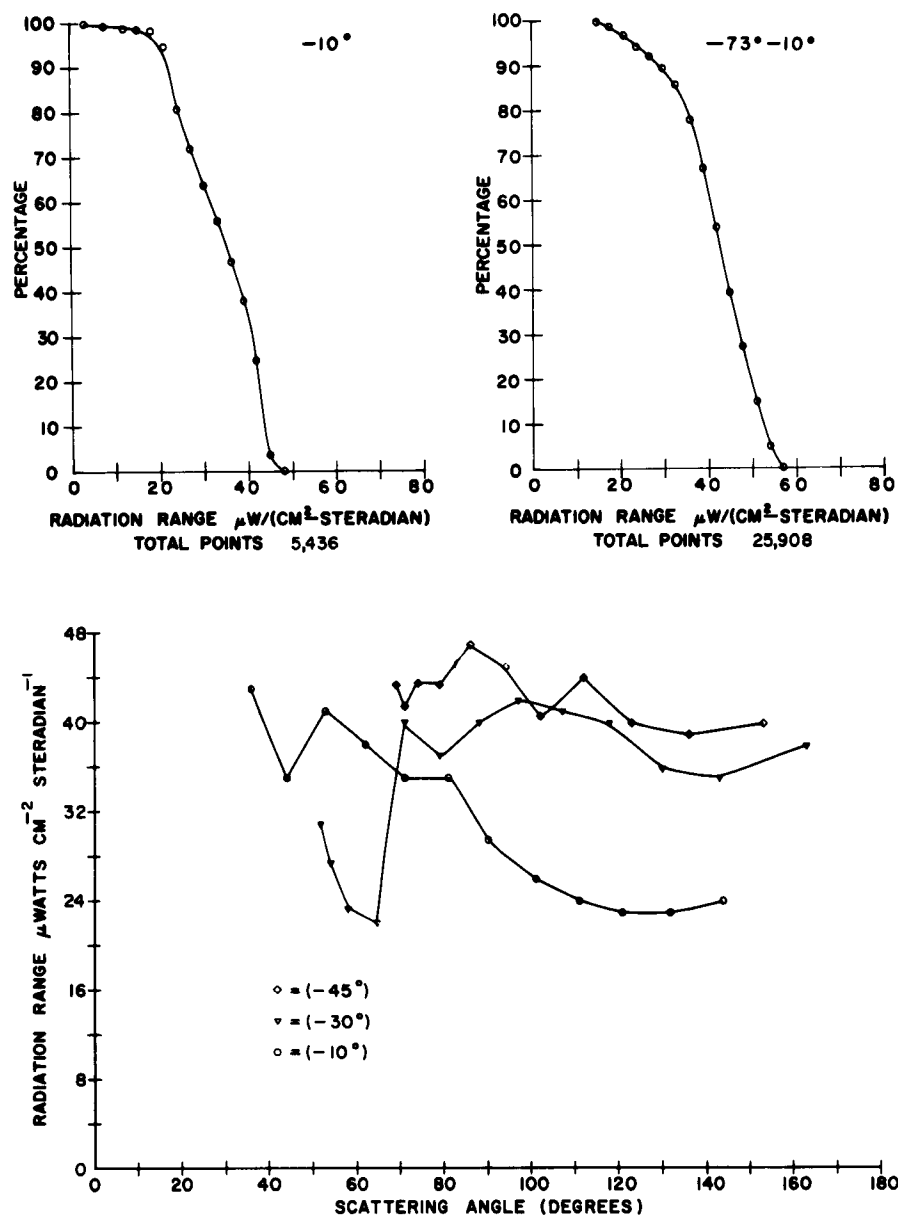
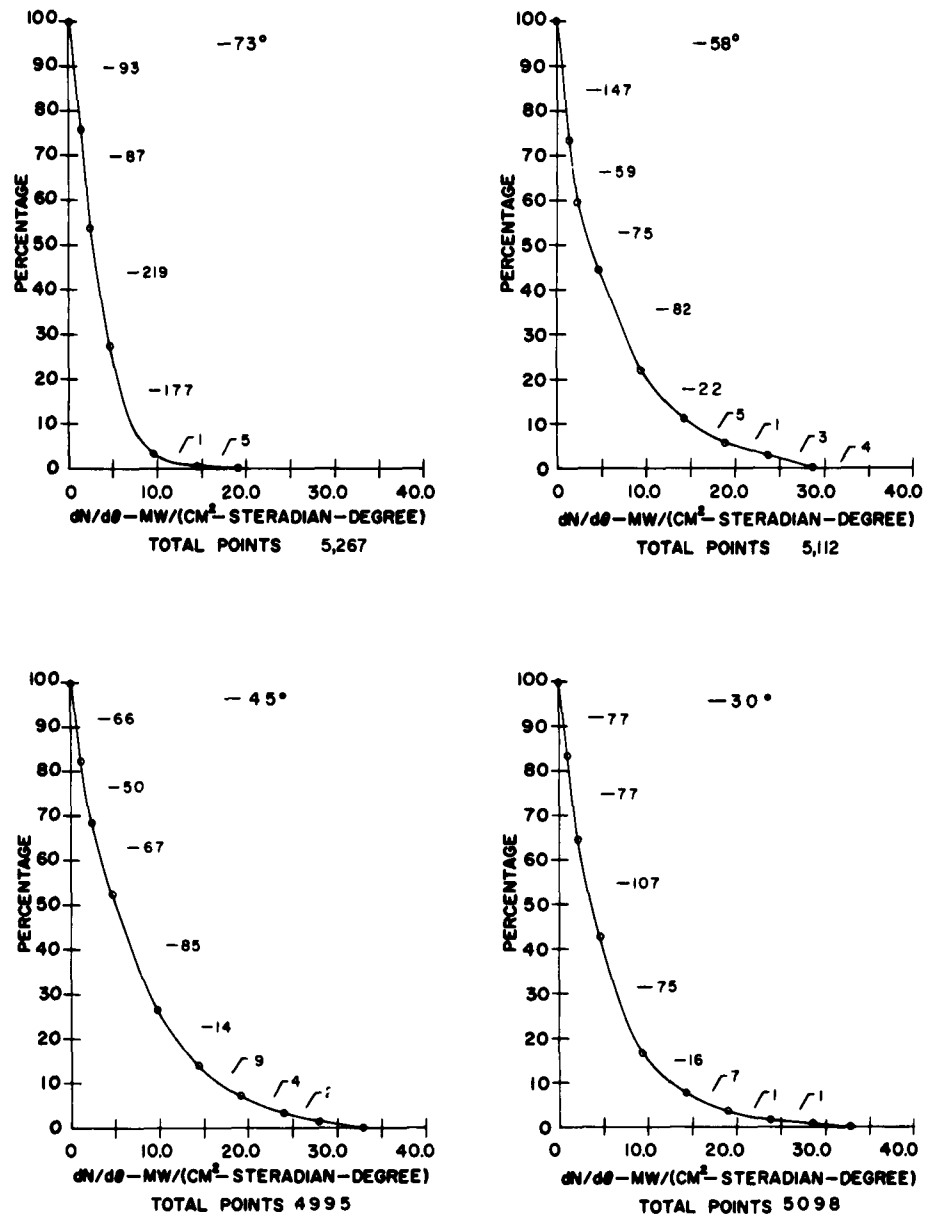


Figure 29 (cont.)



Distribution of IR $dN/d\theta$ with Elevation
 Filter No. 3 7:50-8:00 M.S.T.
 Altitude 31.1 km

Figure 30

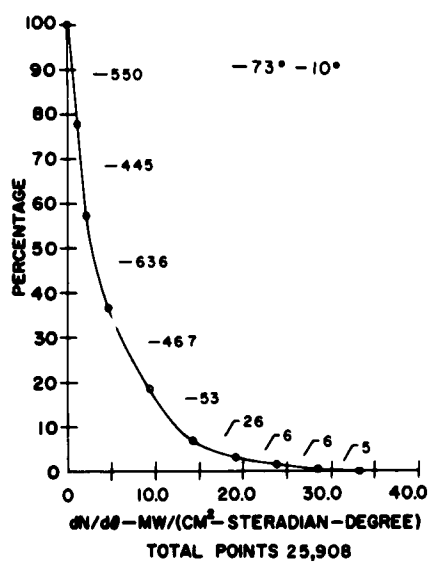
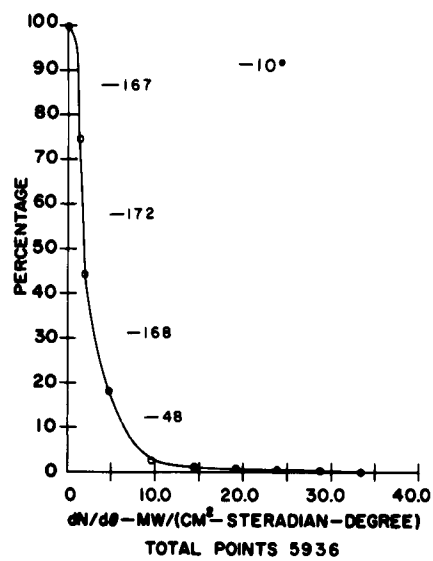
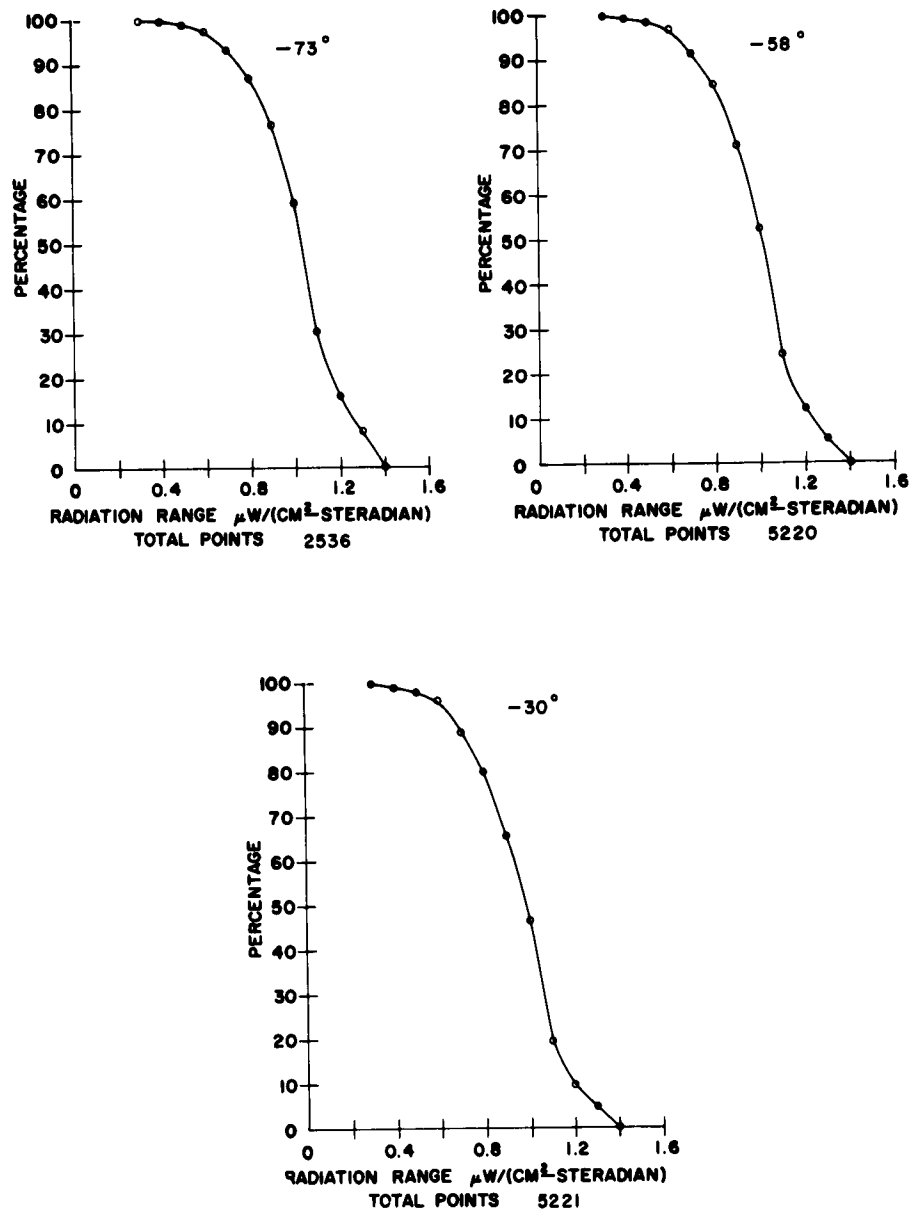


Figure 30 (cont.)



Distribution of IR Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 2 8:00-8:05 M.S.T.
 Altitude 31.1 km

Figure 31

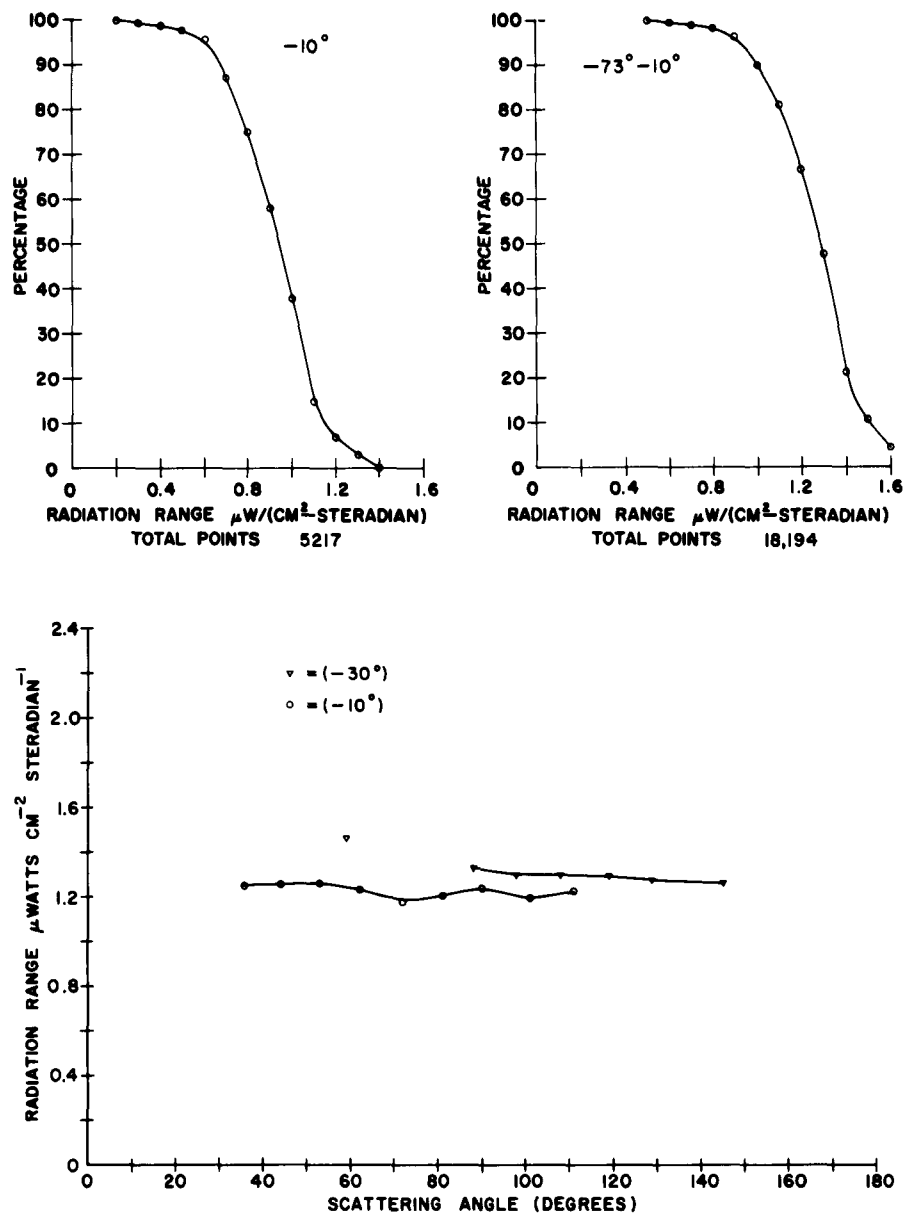
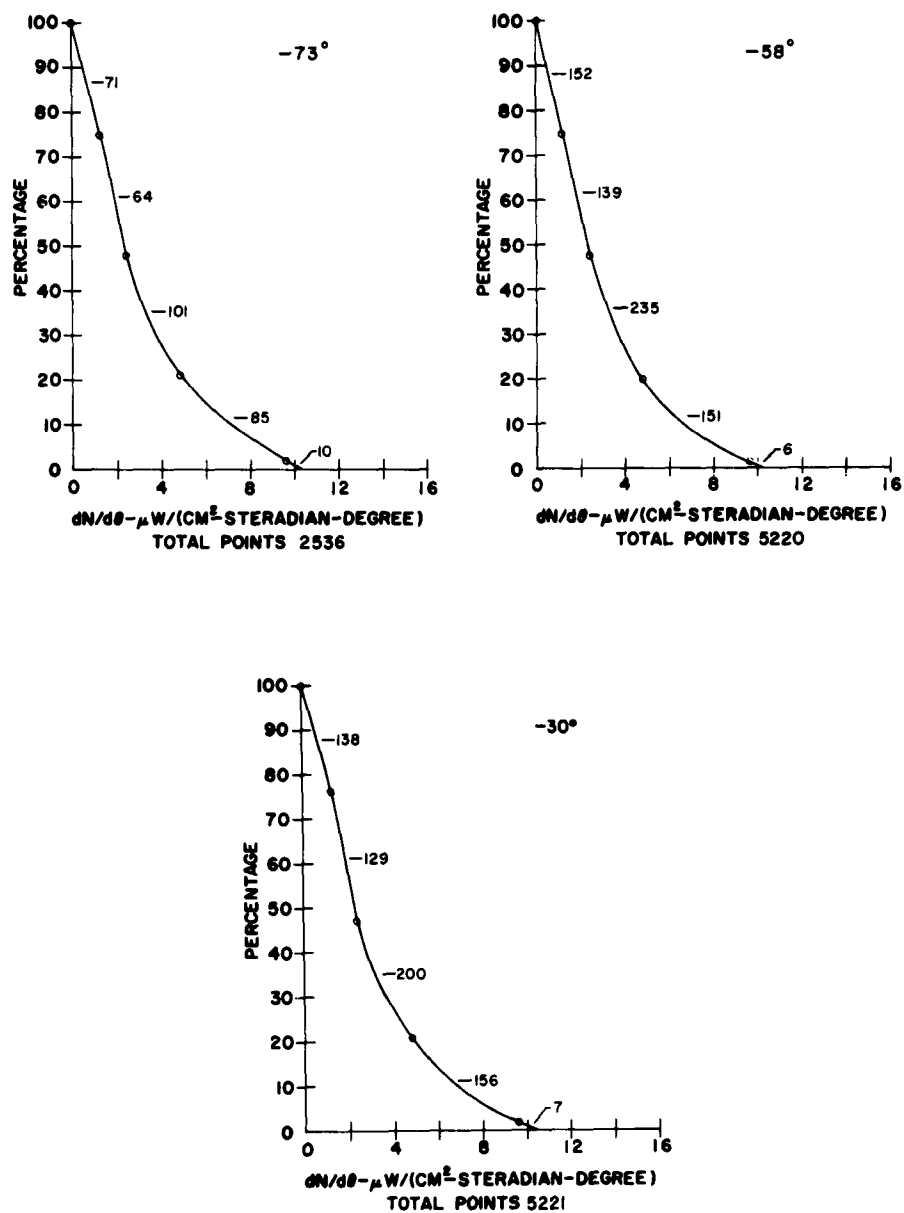


Figure 31 (cont.)



Distribution of IR $dN/d\theta$ with Elevation
 Filter No. 2 8:00-8:05 M.S.T.
 Altitude 31.1 km

Figure 32

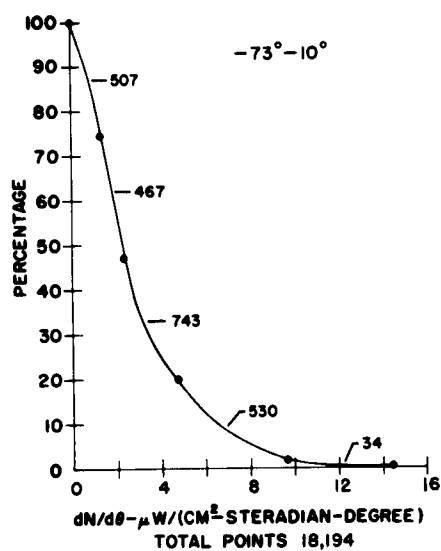
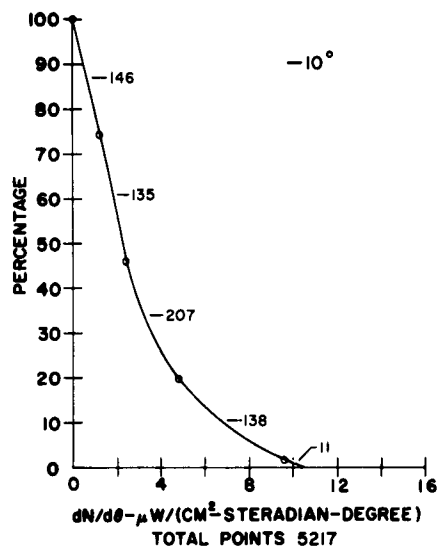
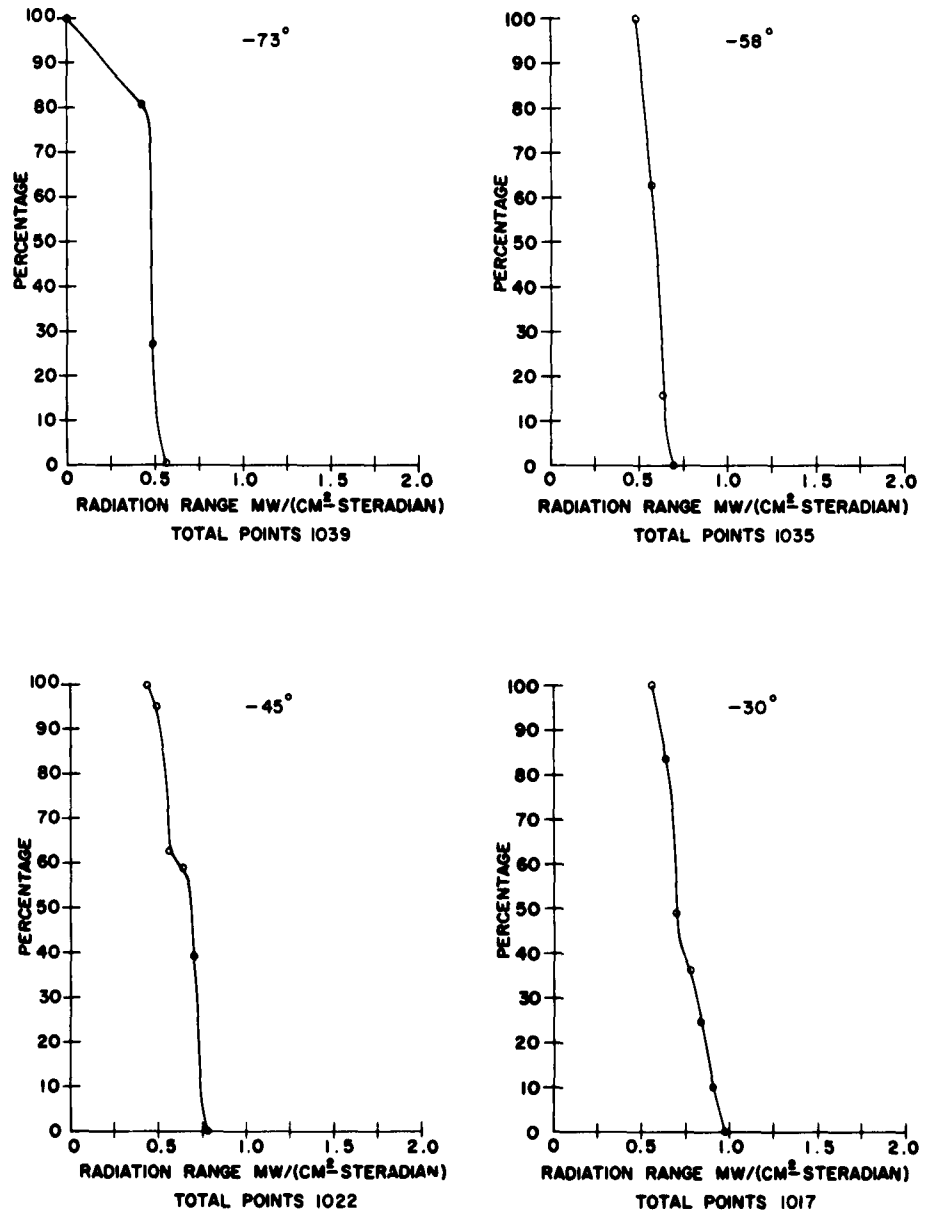


Figure 32 (cont.)



Distribution of UV Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 1 7:20-7:25 M. S. T.
 Altitude 22.4 km

Figure 33

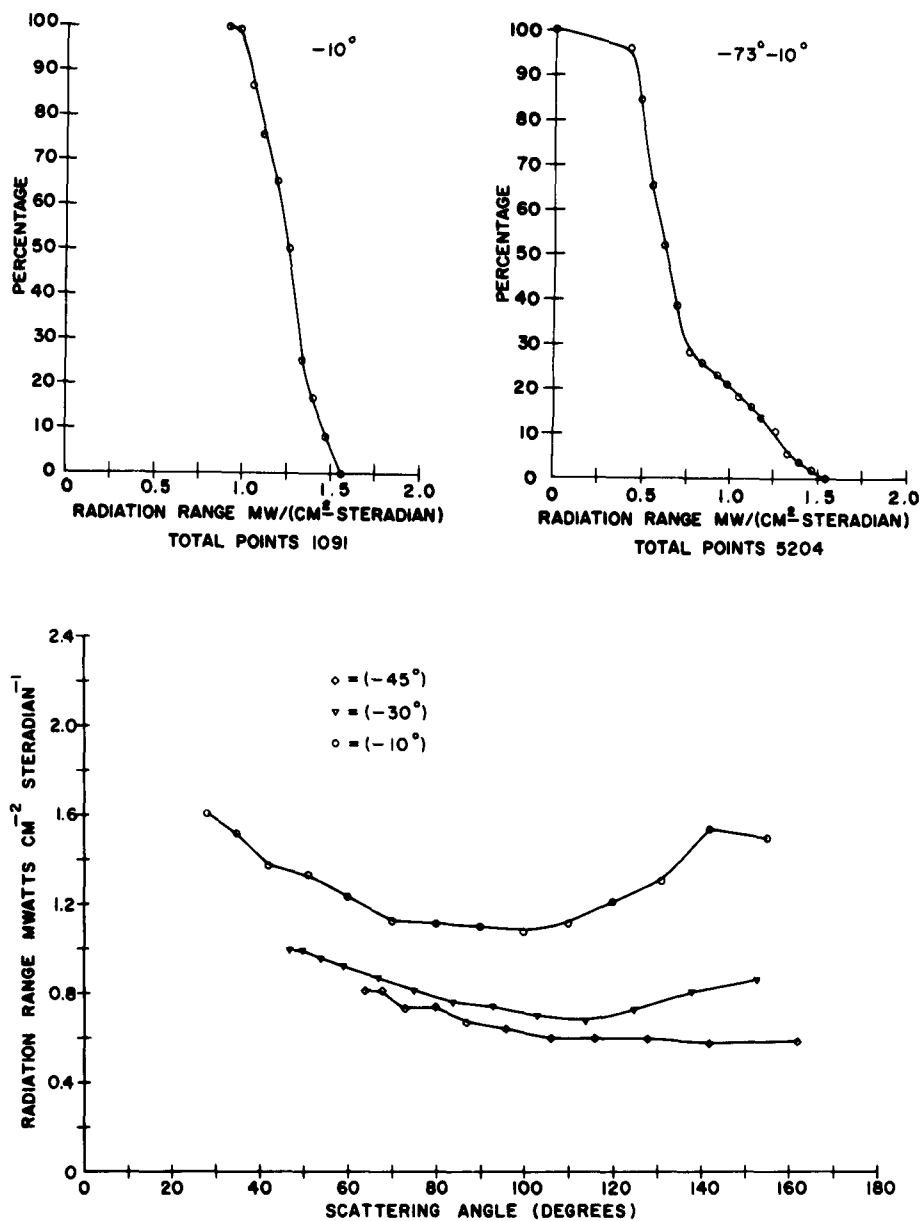
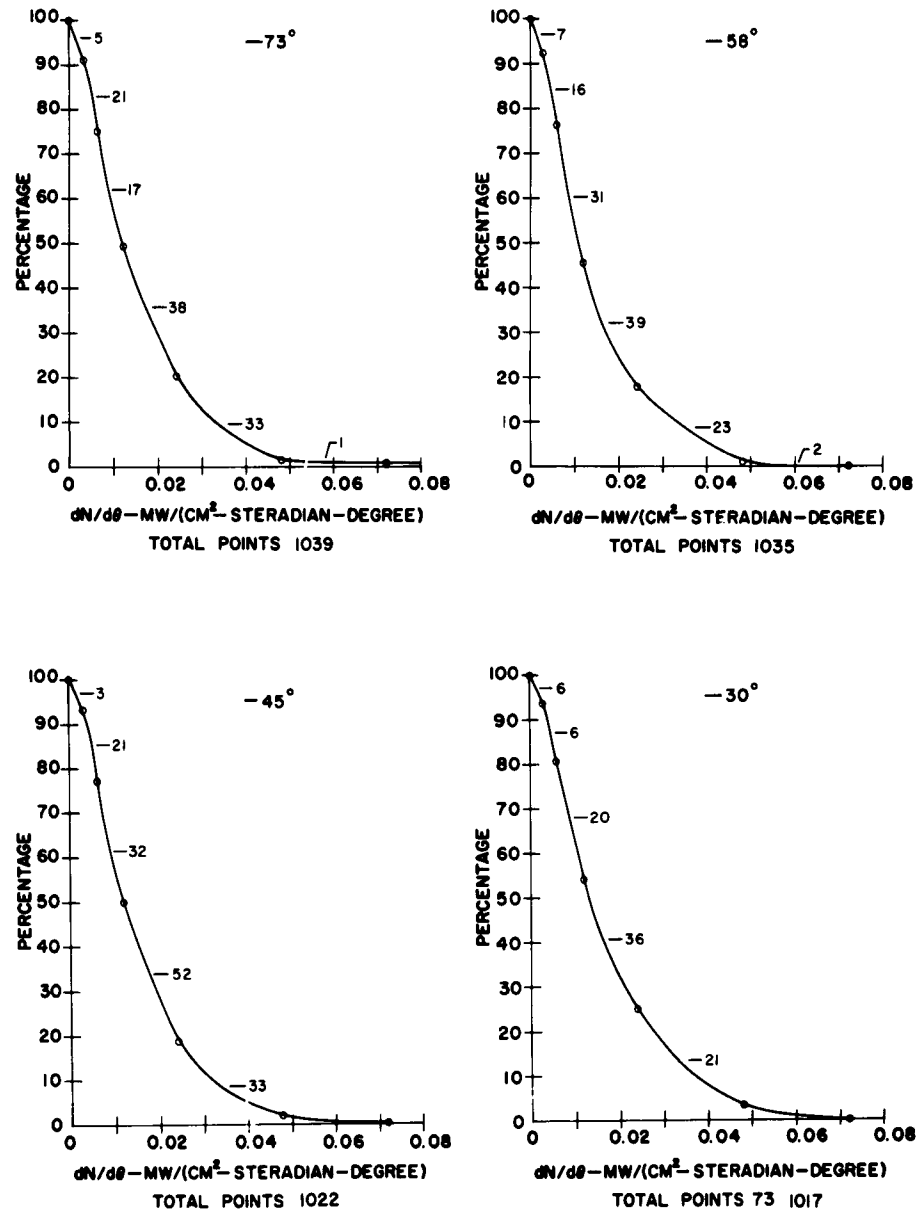


Figure 33 (cont.)



Distribution of UV $dN/d\theta$ with Elevation
 Filter No. 1 7:20-7:25 M. S. T.
 Altitude 22.4 km

Figure 34

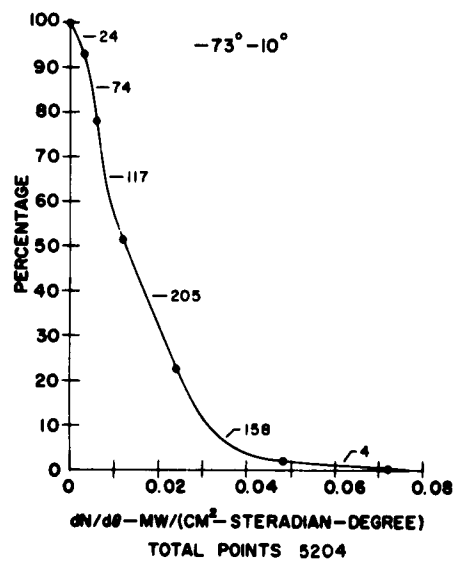
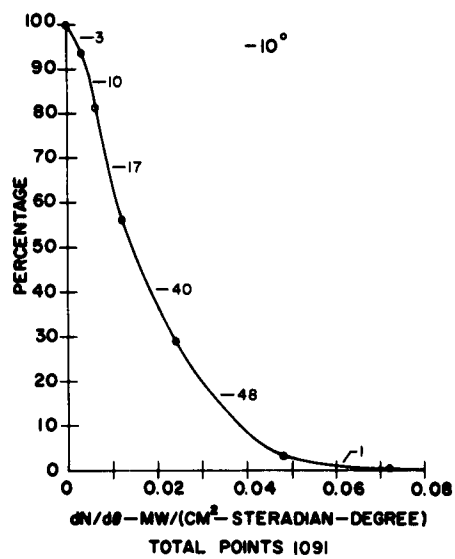
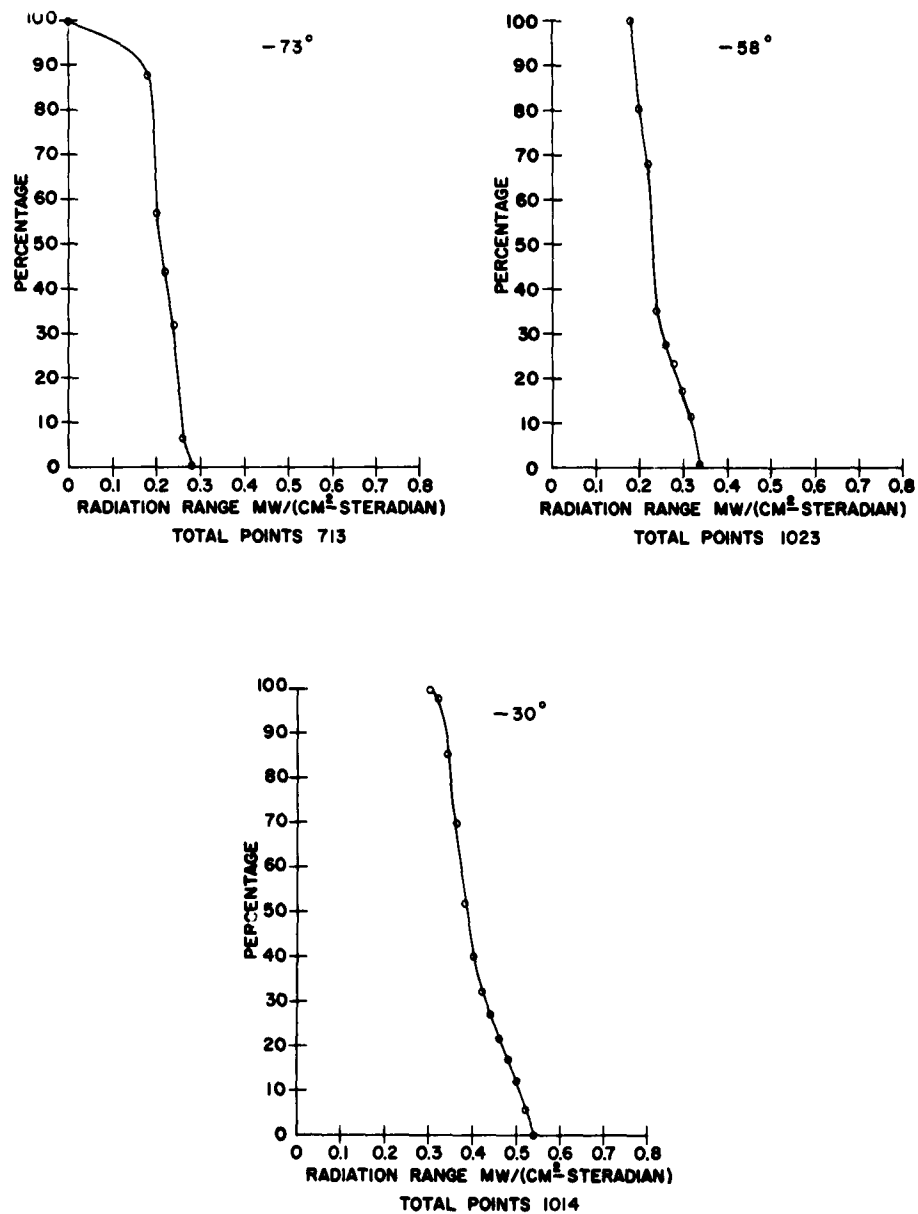


Figure 34 (cont.)



Distribution of UV Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 10 7:45-7:50 M.S.T.
 Altitude 28.3 km

Figure 35

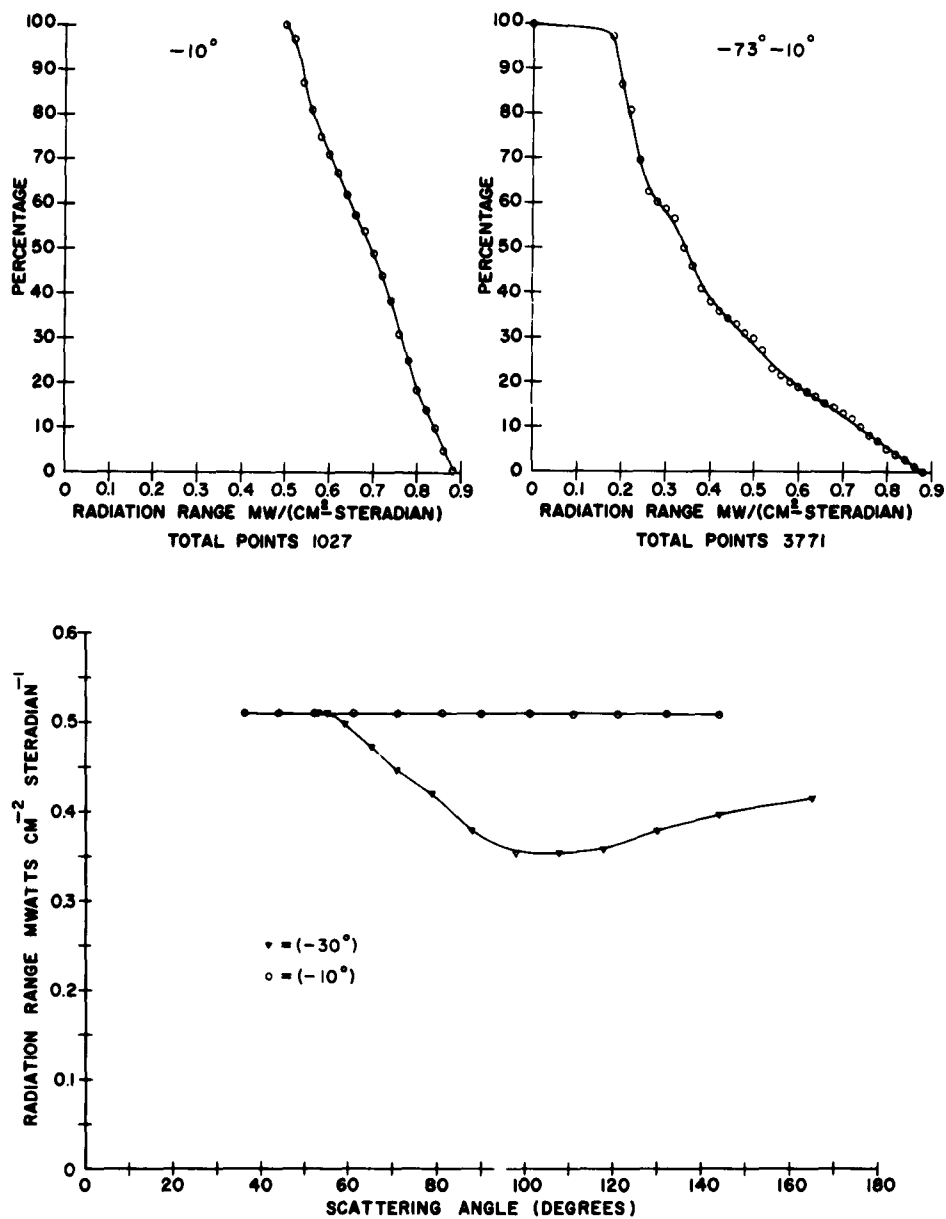
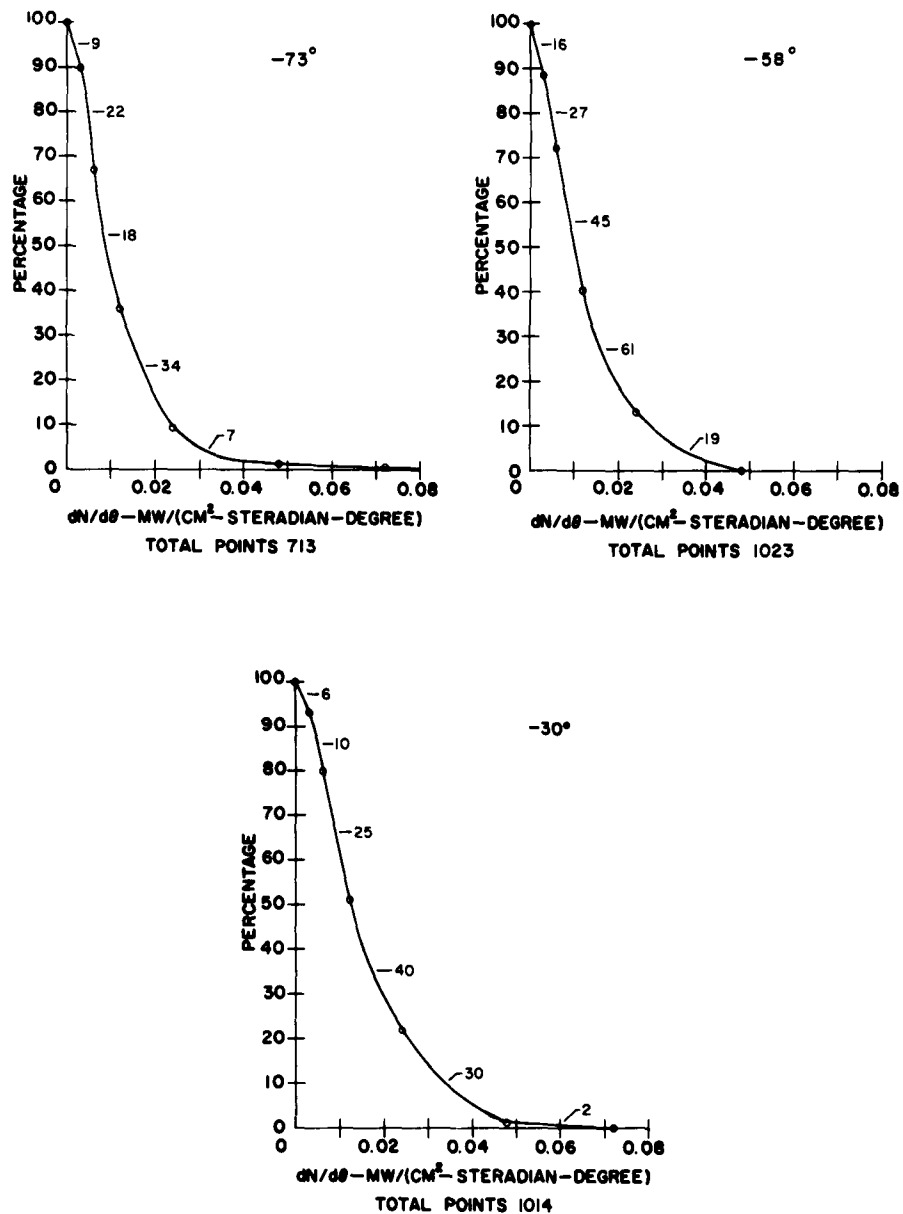


Figure 35 (cont.)



Distribution of UV $dN/d\theta$ with Elevation
 Filter No. 10 7:45-7:50 M.S.T.
 Altitude 28.3 km

Figure 36

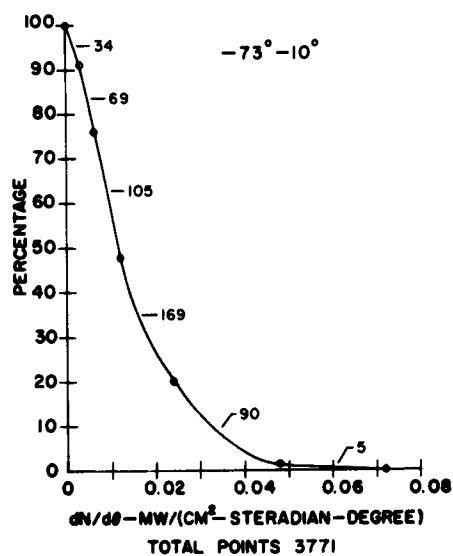
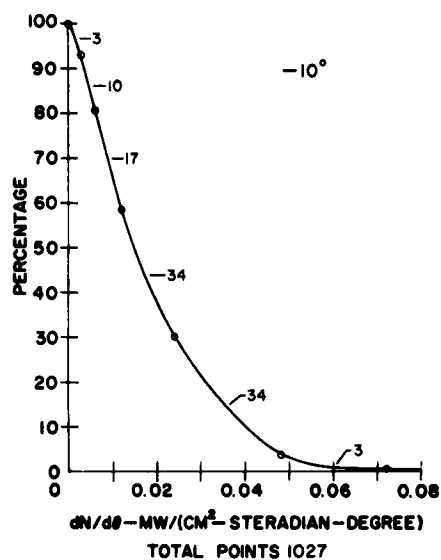
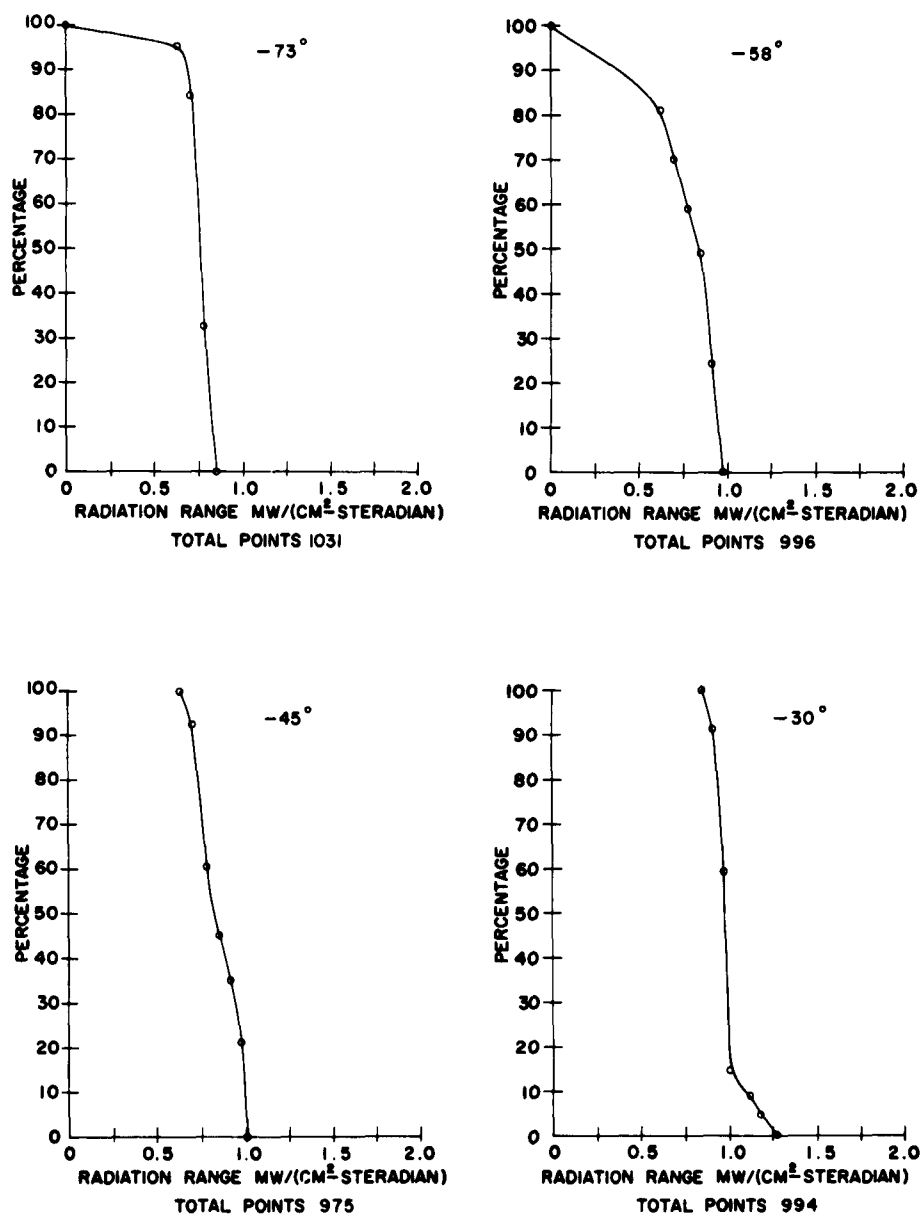


Figure 36 (cont.)



Distribution of UV Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 9 7:50-8:00 M.S.T.
 Altitude 31.1 km

Figure 37

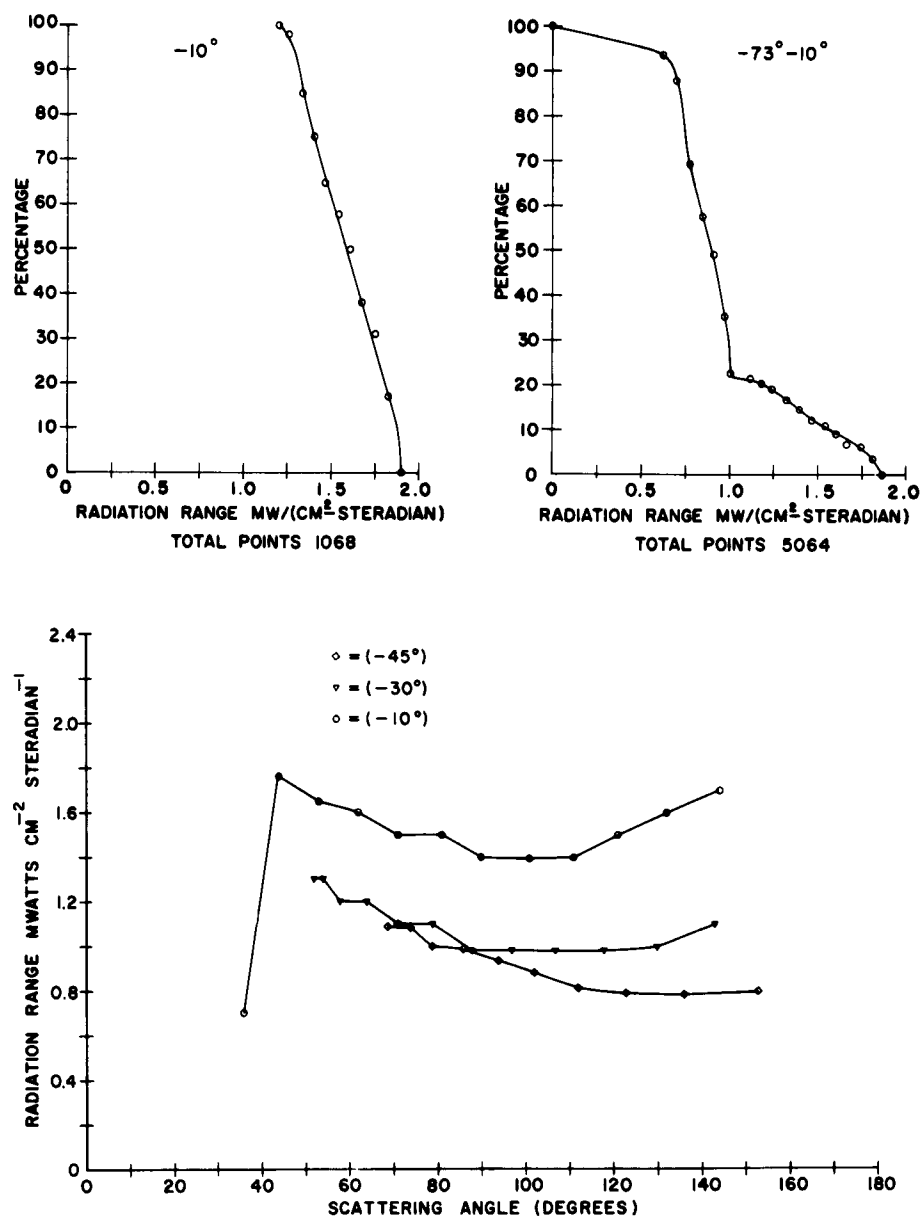
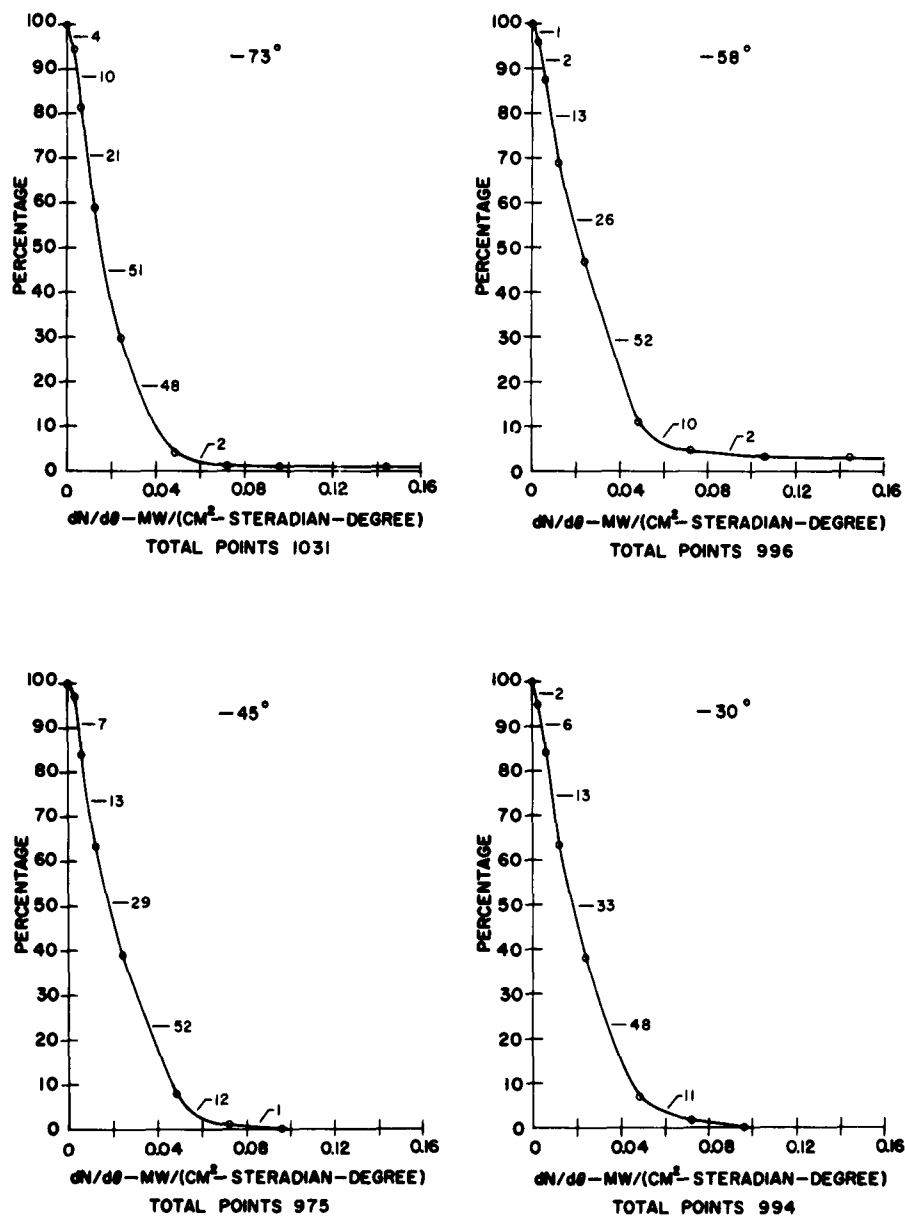


Figure 37 (cont.)



Distribution of UV $dN/d\theta$ with Elevation
 Filter No. 9 7:50-8:00 M.S.T.
 Altitude 31.1 km

Figure 38

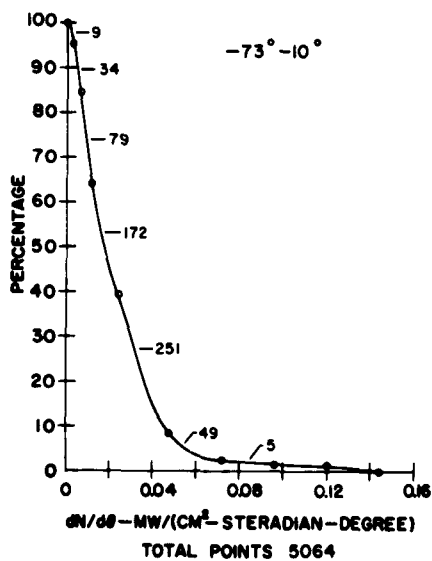
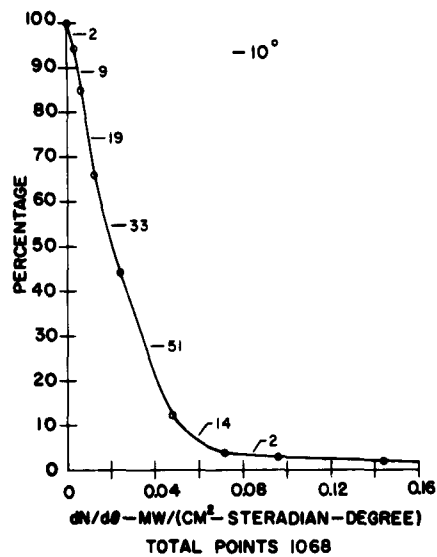
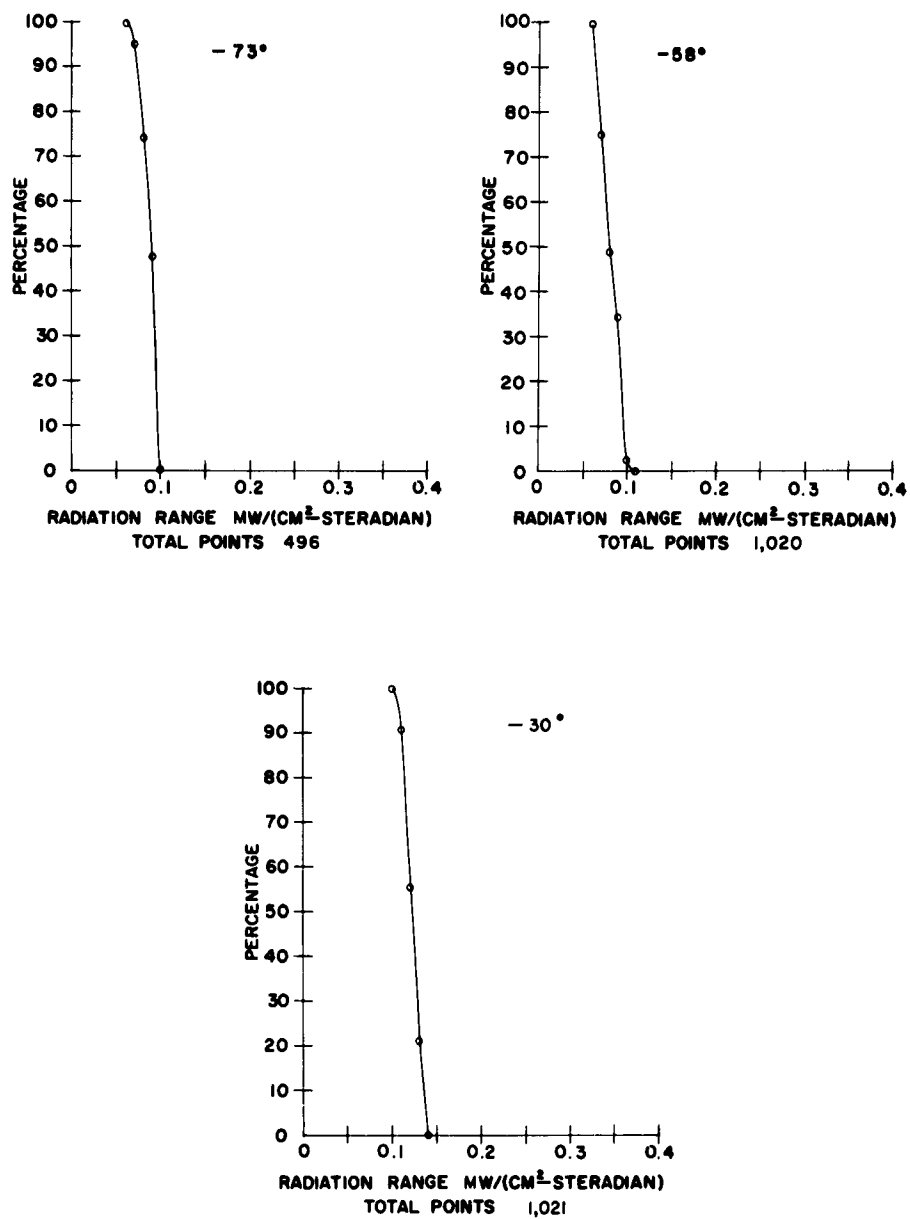


Figure 38 (cont.)



Distribution of UV Radiance with Elevation
 Variance of Radiance with Scattering Angle
 Filter No. 8 8:00-8:05 M.S.T.
 Altitude 31.1 km

Figure 39

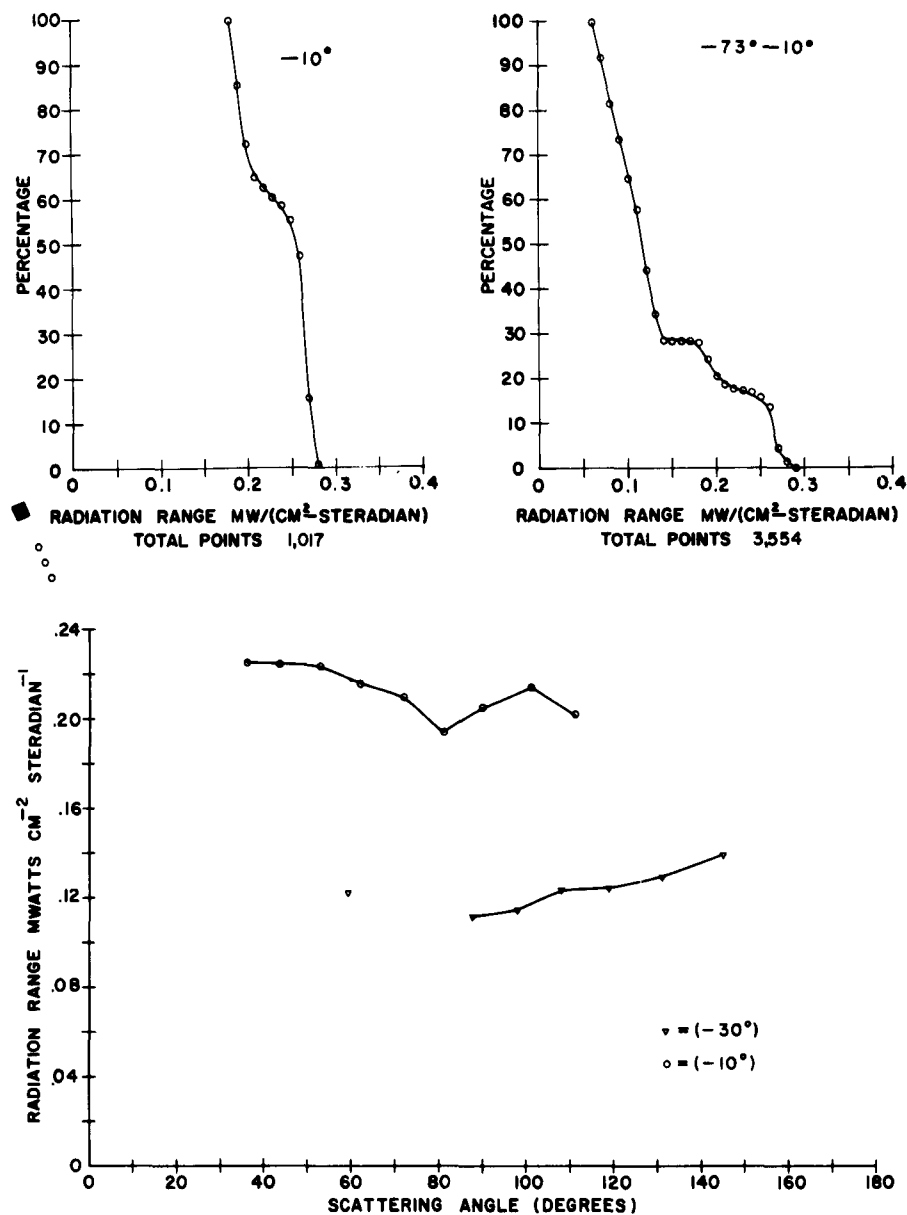
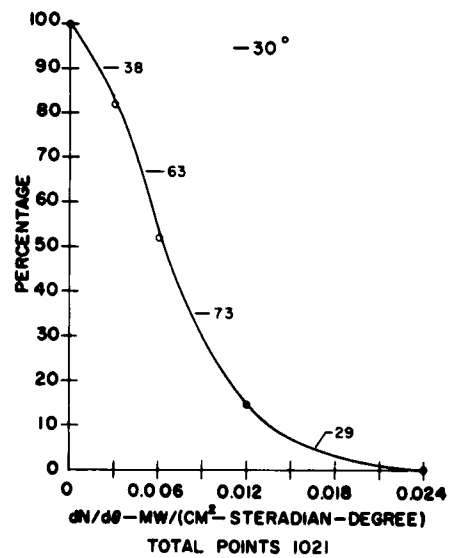
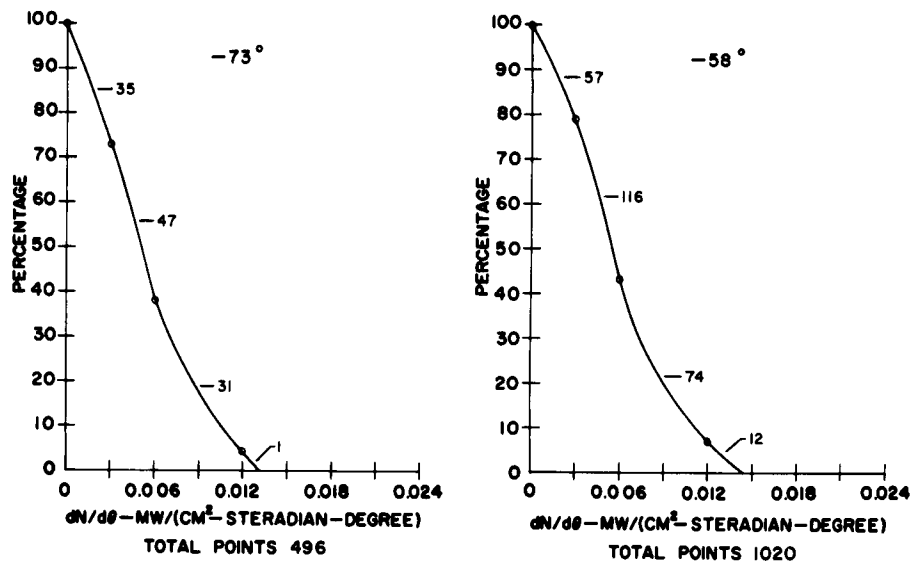


Figure 39 (cont.)



Distribution of UV $dN/d\theta$ with Elevation
 Filter No. 8 8:00-8:05 M.S.T.
 Altitude 31.1 km

Figure 40

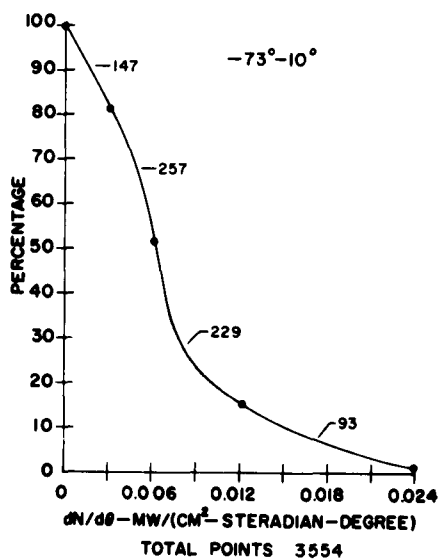
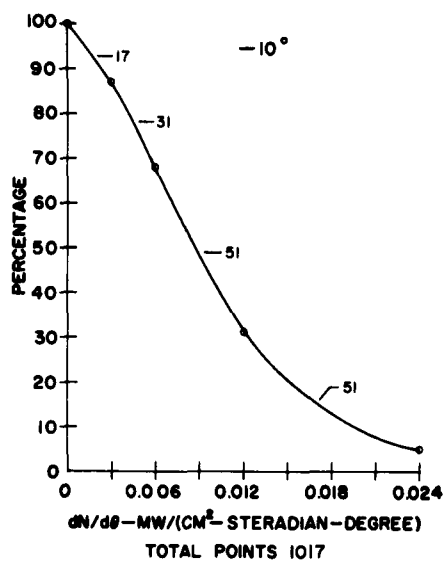


Figure 40 (cont.)

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